

# Neural Network Approximations in Practice

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This monograph is dedicated to our loved ones.

## Preface

In this monograph, we present numerical applications of neural networks approximations, as they are presented for the first time in the recent monograph by the first author, titled “Parametrized, Deformed and General Neural networks” [1], Springer, Heidelberg, New York, 2023. That is confirming with numbers the theoretical results of the above mentioned monograph.

Next, we explain very briefly at simplest possible terms why this is of interest in the studies about neural networks approximation. Let  $h$  be a general sigmoid function with  $h(0) = 0$ , and  $y = 1$  the horizontal asymptotes. Of course  $h$  is strictly increasing over  $\mathbb{R}$ . Let the parameter  $0 < r < 1$  and  $x > 0$ . Then clearly  $-x < x$  and  $-x < -rx < rx < x$ , furthermore it holds  $h(-x) < h(-rx) < h(rx) < h(x)$ . Consequently the sigmoid  $y = h(rx)$  has a graph inside the graph of  $y = h(x)$ , of course with the same asymptotes  $y = 1$ . Therefore  $h(rx)$  has derivatives (gradients) non-zero at more points  $x$  than  $h(x)$  has different than zero or not as close to zero, thus killing a fewer number of neurons! And of course  $h(rx)$  is more distant from  $y = 1$ , than  $h(x)$  is. This is the main concern in choosing the proper activation function, which is a highly desired fact in Neural Networks theory. Also different activation functions allow for different non-linearities which might work better for solving a specific function. So the need to use neural networks with various activation functions is vivid. Thus, performing neural network approximations using different activation functions is not only necessary but fully justified.

Furthermore, the brain non-symmetry has been observed in animals and humans in terms of structure, function and behavior. This lateralization is thought to reflect evolutionary, hereditary, developmental, experiential and pathological factors. Consequently, it is natural to consider for our study deformed neural network activation functions and operators. Thus, this book is the appropriate study covering a great variety of applications and approaching reality as close as possible.

Our numerical applications cover the univariate case extensively in a great number of cases by employing SageMath [3], a free open-source mathematics software that uses a Python-based programming language.

In each chapter in short we describe the neural network theory involved there.

The engaged activation functions we employ here are:  $\theta$ -Deformed and  $\lambda$ -parametrized half hyperbolic tangent,  $q$ -Deformed and  $\lambda$ -parametrized  $A$ -generalized logistic function.

The book's results are expected to find applications in the many areas of Applied Mathematics, Computer Science and Engineering, especially in Artificial Intelligence, Machine Learning and Deep Learning. Other possible applications can be in applied sciences like Statistics, Economics, etc. All in all what is presented here is a valuable tool for a large range of applications. Therefore this monograph is suitable for researchers, graduate students, practitioners and seminars of the above disciplines, also to be in all Science and Engineering libraries.

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# 1 Introduction

This work is meant to be a companion to the published monograph of G.A. Anastassiou [Parametrized, Deformed and General Neural Networks, Springer, Heidelberg, New York, 2023], where the theoretical foundations for these results have already been established. In particular, in there, it was proven that the various operators presented below converge quantitatively to the identity operator.

In this current work would like to give our readers a sense of the error of approximation for various operators and particular values of  $n$ , parameter  $\lambda$ , deformation coefficient  $q$ , activation functions, density functions, neural network operators, and intervals applied for various functions. We estimate the error of approximation of the various neural network operators, and also compare the results to various monomial polynomial functions.

Please note the following:

- the code below was run using SageMath [3] version 9.5.
- the estimates in this book are all subject to the error of approximation inherent from using SageMath as a tool and how floating point numbers are represented on computer systems. This error of approximation accumulates as we do more and more iterations.
- some tests are not complete - after running for a long time, a runtime error occurred and some computations stalled.
- the reader is strongly advised to read and understand the code prior to reading the numerical results. The code is written in a simple way so it is understandable even for non computer scientists. The "left side" of our computations represents the error of approximation to the function by neural network operators. This error is compared to anticipated speeds of convergence and expressed by the "difference" values shown in every computational result.

## 2 Real-valued neural network approximation based on the $q$ -deformed and $\lambda$ -parametrized half hyperbolic tangent - introduction

We present in here some of the background and the main result that was proven in the monograph [Parametrized, Deformed and General Neural Networks, Springer, Heidelberg, New York, 2023], in Chapter 20.

The **activation function** [see monograph, formula 20.1] used for this part is defined as follows:

$$\varphi_q(t) := \frac{1 - qe^{-\beta t}}{1 + qe^{-\beta t}}, \forall t \in \mathbb{R}, \text{ where } q, \beta > 0. \quad (1)$$

Then [see monograph, formula 20.8], we present the **density function**, the  $q$ -deformed and  $\lambda$ -parametrized half hyperbolic tangent (which, in the SageMath code below was named theta(x) for consistency between all SageMath code presented in this current work):

$$\phi_q(x) := \frac{1}{4}(\varphi_q(x+1) - \varphi_q(x-1)) > 0, \forall x \in \mathbb{R}, \text{ where } q, \beta > 0. \quad (2)$$

Lastly, [see monograph, formula 20.27], we give the real-valued **linear neural network operators**:

$$H_n(f, x) := \frac{\sum_{k=\lceil na \rceil}^{\lfloor nb \rfloor} f\left(\frac{k}{n}\right) \phi_q(nx - k)}{\sum_{k=\lceil na \rceil}^{\lfloor nb \rfloor} \phi_q(nx - k)}, \text{ where } f \in C([a, b]), x \in [a, b], q, \beta > 0. \quad (3)$$

It was shown [see monograph, Theorem 20.9], that:

$$\lim_{n \rightarrow \infty} H_n(f) = f, \quad (4)$$

pointwise and uniformly.



Next, we present our computational results using SageMath. Please note that we removed several of the results generated by the code below.

### 3 Real-valued neural network approximation based on the $q$ -deformed and $\lambda$ -parametrized half hyperbolic tangent - part 1

```
[ ]: RR.scientific_notation(True)
powers = [3/10, 1/2, 7/10]
lamdas = [1/4, 1/2, 1]    #deformation parameter lamda over (0, 1]
    ↪ 1] - these are the beta values in the formula
qs = [1/4, 1/2, 1]    #deformation coefficient

funcs = [sin(x), cos(x)]    #choice of functions
a = -pi    #the interval
b = pi    #the interval
x0s= [pi/4, pi/2, 3*pi/4]

#####
for x0 in x0s:
    #####
        for power in powers:    #going over various powers for 1/
            ↪ n^power
                ↪
                    #####
                        for lamda in lamdas:    #going over each lamda value
                            ↪
                                #####
                                    for q in qs:    #going over each q value
                                        ↪
                                            #####
                                                print()
                                                print()
                                                    ↪
                                                        ↪ print("-----")
```

```

        print("x0 = " + str(x0)+" , Power = "+
↪str(power)+ " , lamda = "+ str(lamda) + " , q = " + str(q))
        ↪
↪print("-----")
        #the activation function
        phi(x) = (1-q*(e^(-lamda*x)))/
↪(1+q*(e^(-lamda*x))) #formula 20.1

        #q-deformed and  $\beta$ -parametrized half hyperbolic
↪tangent
        theta(x) = 1/4*(phi(x+1) - phi(x-1)) ↪
↪#formula 20.8

        ↪
↪#####
        for i in range(len(funcs)):
            ↪
            ↪#####
            f(x)=funcs[i]
            show(f(x))
            for n in [10, 20, 50, 100, 200, 500]:
                #def H(n, f, x): #real-valued ↪
↪linear neural network operators
                # return sum(f(k/n)*theta(n*x-k) ↪
↪for k in [ceil(n*a),...,floor(n*b)])/sum(theta(n*x-k) for k ↪
↪in [ceil(n*a),...,floor(n*b)])
                #leftSide = abs(H(n,f,x0)-f(x0))
                leftSide = abs(sum(f(k/
↪n)*theta(n*x0-k) for k in [ceil(n*a),...,floor(n*b)])/
↪sum(theta(n*x0-k) for k in [ceil(n*a),...,floor(n*b)]) -
↪f(x0))

                val1 = n
                val2 = leftSide.n()
                val3 = 1/(n^power).n()

```

```

                                print("          n = "+str(val1), ",␣
↪left side = "+str(val2),
                                "\n          1/
↪n^("+str(power)+") = "+str(val3),
                                "\n          ␣
↪difference = "+str(val3-val2))

```

-----  
 $x_0 = 1/4\pi$ , Power = 3/10, lamda = 1/4, q = 1/4  
 -----

$\sin(x)$

```

n = 10 , left side = 6.14723251420852e-2
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.39714908485187e-1
n = 20 , left side = 1.11294566010310e-1
          1/n^(3/10) = 4.07090531536904e-1
          difference = 2.95795965526594e-1
n = 50 , left side = 6.57022757028688e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.43547219008123e-1
n = 100 , left side = 3.61332770545404e-2
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.15055366096418e-1
n = 200 , left side = 1.88501016814132e-2
          1/n^(3/10) = 2.04028577336837e-1
          difference = 1.85178475655424e-1
n = 500 , left side = 7.72268598453840e-3
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.47269212770295e-1

```

$\cos(x)$

```

n = 10 , left side = 5.17973276214348e-1
          1/n^(3/10) = 5.01187233627272e-1
          difference = -1.67860425870752e-2
n = 20 , left side = 2.51295039601676e-1
          1/n^(3/10) = 4.07090531536904e-1
          difference = 1.55795491935229e-1
n = 50 , left side = 8.91716716056313e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.20077823105360e-1
n = 100 , left side = 4.20399787268633e-2
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.09148664424095e-1
n = 200 , left side = 2.03292531654996e-2
          1/n^(3/10) = 2.04028577336837e-1
          difference = 1.83699324171337e-1
n = 500 , left side = 7.95946134048608e-3
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.47032437414348e-1

```

-----  
 $x_0 = 1/4\pi$ , Power = 3/10, lamda = 1/4, q = 1/2  
 -----

$\sin(x)$

```

n = 10 , left side = 2.25818738884073e-2
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.78605359738865e-1
n = 20 , left side = 4.04453908761683e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.66645140660736e-1
n = 50 , left side = 3.02663846427300e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.78983110068262e-1
n = 100 , left side = 1.74104170545998e-2

```

```

1/n^(3/10) = 2.51188643150958e-1
difference = 2.33778226096358e-1
n = 200 , left side = 9.25989196858323e-3
1/n^(3/10) = 2.04028577336837e-1
difference = 1.94768685368254e-1
n = 500 , left side = 3.83481978962907e-3
1/n^(3/10) = 1.54991898754834e-1
difference = 1.51157078965205e-1

```

$\cos(x)$

```

n = 10 , left side = 3.22248031460382e-1
1/n^(3/10) = 5.01187233627272e-1
difference = 1.78939202166890e-1
n = 20 , left side = 1.42602604325762e-1
1/n^(3/10) = 4.07090531536904e-1
difference = 2.64487927211142e-1
n = 50 , left side = 4.72897971848895e-2
1/n^(3/10) = 3.09249494710992e-1
difference = 2.61959697526102e-1
n = 100 , left side = 2.16912390801813e-2
1/n^(3/10) = 2.51188643150958e-1
difference = 2.29497404070777e-1
n = 200 , left side = 1.03316679895296e-2
1/n^(3/10) = 2.04028577336837e-1
difference = 1.93696909347307e-1
n = 500 , left side = 4.00637442698670e-3
1/n^(3/10) = 1.54991898754834e-1
difference = 1.50985524327847e-1

```

-----  
 $x_0 = 1/4\pi$ , Power = 3/10, lamda = 1/4, q = 1  
 -----

$\sin(x)$

$n = 10$  , left side = 1.55169425547731e-1  
 $1/n^{(3/10)} = 5.01187233627272e-1$   
difference = 3.46017808079542e-1  
 $n = 20$  , left side = 4.47376351803206e-2  
 $1/n^{(3/10)} = 4.07090531536904e-1$   
difference = 3.62352896356584e-1  
 $n = 50$  , left side = 7.43627371125710e-3  
 $1/n^{(3/10)} = 3.09249494710992e-1$   
difference = 3.01813220999735e-1  
 $n = 100$  , left side = 1.86936162198503e-3  
 $1/n^{(3/10)} = 2.51188643150958e-1$   
difference = 2.49319281528973e-1  
 $n = 200$  , left side = 4.67987750301657e-4  
 $1/n^{(3/10)} = 2.04028577336837e-1$   
difference = 2.03560589586535e-1  
 $n = 500$  , left side = 7.49070874977997e-5  
 $1/n^{(3/10)} = 1.54991898754834e-1$   
difference = 1.54916991667336e-1

$$\cos(x)$$

$n = 10$  , left side = 1.53728257318856e-1  
 $1/n^{(3/10)} = 5.01187233627272e-1$   
difference = 3.47458976308417e-1  
 $n = 20$  , left side = 4.47310387031025e-2  
 $1/n^{(3/10)} = 4.07090531536904e-1$   
difference = 3.62359492833802e-1  
 $n = 50$  , left side = 7.43627371112354e-3  
 $1/n^{(3/10)} = 3.09249494710992e-1$   
difference = 3.01813220999868e-1  
 $n = 100$  , left side = 1.86936162198525e-3  
 $1/n^{(3/10)} = 2.51188643150958e-1$   
difference = 2.49319281528973e-1  
 $n = 200$  , left side = 4.67987750301324e-4  
 $1/n^{(3/10)} = 2.04028577336837e-1$   
difference = 2.03560589586536e-1

```

n = 500 , left side = 7.49070874974667e-5
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.54916991667336e-1

```

-----  
 $x_0 = 1/4\pi$ , Power = 3/10, lamda = 1/2, q = 1/4  
 -----

$\sin(x)$

```

n = 10 , left side = 1.10269377456684e-1
          1/n^(3/10) = 5.01187233627272e-1
          difference = 3.90917856170588e-1
n = 20 , left side = 7.76237576737794e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.29466773863125e-1
n = 50 , left side = 3.60961153613111e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.73153379349681e-1
n = 100 , left side = 1.88410272392819e-2
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.32347615911676e-1
n = 200 , left side = 9.61343382830959e-3
          1/n^(3/10) = 2.04028577336837e-1
          difference = 1.94415143508527e-1
n = 500 , left side = 3.89095422715502e-3
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.51100944527679e-1

```

$\cos(x)$

```

n = 10 , left side = 2.51869405006841e-1
          1/n^(3/10) = 5.01187233627272e-1
          difference = 2.49317828620431e-1
n = 20 , left side = 1.14542456854608e-1

```

```

1/n^(3/10) = 4.07090531536904e-1
difference = 2.92548074682296e-1
n = 50 , left side = 4.20732317898761e-2
1/n^(3/10) = 3.09249494710992e-1
difference = 2.67176262921116e-1
n = 100 , left side = 2.03378378667143e-2
1/n^(3/10) = 2.51188643150958e-1
difference = 2.30850805284244e-1
n = 200 , left side = 9.98779497231439e-3
1/n^(3/10) = 2.04028577336837e-1
difference = 1.94040782364523e-1
n = 500 , left side = 3.95085911348825e-3
1/n^(3/10) = 1.54991898754834e-1
difference = 1.51041039641345e-1

```

-----  
 $x_0 = 1/4\pi$ , Power = 3/10, lamda = 1/2, q = 1/2  
 -----

```

sin(x)

n = 10 , left side = 3.95100600139322e-2
1/n^(3/10) = 5.01187233627272e-1
difference = 4.61677173613340e-1
n = 20 , left side = 3.46988342396720e-2
1/n^(3/10) = 4.07090531536904e-1
difference = 3.72391697297232e-1
n = 50 , left side = 1.73741914965689e-2
1/n^(3/10) = 3.09249494710992e-1
difference = 2.91875303214423e-1
n = 100 , left side = 9.25093740382410e-3
1/n^(3/10) = 2.51188643150958e-1
difference = 2.41937705747134e-1
n = 200 , left side = 4.76419447265519e-3
1/n^(3/10) = 2.04028577336837e-1

```



```

        difference = 1.99264382864182e-1
n = 500 , left side = 1.93866173914448e-3
        1/n^(3/10) = 1.54991898754834e-1
        difference = 1.53053237015689e-1

```

$\cos(x)$

```

n = 10 , left side = 1.43310623580410e-1
        1/n^(3/10) = 5.01187233627272e-1
        difference = 3.57876610046862e-1
n = 20 , left side = 6.16155530779093e-2
        1/n^(3/10) = 4.07090531536904e-1
        difference = 3.45474978458995e-1
n = 50 , left side = 2.17255095716977e-2
        1/n^(3/10) = 3.09249494710992e-1
        difference = 2.87523985139294e-1
n = 100 , left side = 1.03403776602990e-2
        1/n^(3/10) = 2.51188643150958e-1
        difference = 2.40848265490659e-1
n = 200 , left side = 5.03665536910614e-3
        1/n^(3/10) = 2.04028577336837e-1
        difference = 1.98991921967731e-1
n = 500 , left side = 1.98226000171697e-3
        1/n^(3/10) = 1.54991898754834e-1
        difference = 1.53009638753117e-1

```

---

$x_0 = 1/4\pi$ , Power = 3/10, lamda = 1/2, q = 1

---

$\sin(x)$

```

n = 10 , left side = 4.55658979518567e-2
        1/n^(3/10) = 5.01187233627272e-1
        difference = 4.55621335675416e-1

```

$n = 20$  , left side =  $1.17886898348858e-2$   
 $1/n^{(3/10)} = 4.07090531536904e-1$   
difference =  $3.95301841702019e-1$   
 $n = 50$  , left side =  $1.90462319911511e-3$   
 $1/n^{(3/10)} = 3.09249494710992e-1$   
difference =  $3.07344871511877e-1$   
 $n = 100$  , left side =  $4.76820716817206e-4$   
 $1/n^{(3/10)} = 2.51188643150958e-1$   
difference =  $2.50711822434141e-1$   
 $n = 200$  , left side =  $1.19246801639439e-4$   
 $1/n^{(3/10)} = 2.04028577336837e-1$   
difference =  $2.03909330535198e-1$   
 $n = 500$  , left side =  $1.90813536953272e-5$   
 $1/n^{(3/10)} = 1.54991898754834e-1$   
difference =  $1.54972817401138e-1$

$\cos(x)$

$n = 10$  , left side =  $4.55601836086841e-2$   
 $1/n^{(3/10)} = 5.01187233627272e-1$   
difference =  $4.55627050018588e-1$   
 $n = 20$  , left side =  $1.17886897702850e-2$   
 $1/n^{(3/10)} = 4.07090531536904e-1$   
difference =  $3.95301841766619e-1$   
 $n = 50$  , left side =  $1.90462319911522e-3$   
 $1/n^{(3/10)} = 3.09249494710992e-1$   
difference =  $3.07344871511877e-1$   
 $n = 100$  , left side =  $4.76820716817428e-4$   
 $1/n^{(3/10)} = 2.51188643150958e-1$   
difference =  $2.50711822434141e-1$   
 $n = 200$  , left side =  $1.19246801639661e-4$   
 $1/n^{(3/10)} = 2.04028577336837e-1$   
difference =  $2.03909330535197e-1$   
 $n = 500$  , left side =  $1.90813536955492e-5$   
 $1/n^{(3/10)} = 1.54991898754834e-1$   
difference =  $1.54972817401138e-1$

-----  
 $x_0 = 1/4\pi$ , Power = 3/10, lamda = 1, q = 1/4  
 -----

$\sin(x)$

```

n = 10 , left side = 7.66430508778088e-2
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.24544182749464e-1
n = 20 , left side = 4.38693273663758e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.63221204170529e-1
n = 50 , left side = 1.88047297835470e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.90444764927445e-1
n = 100 , left side = 9.60447473250958e-3
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.41584168418448e-1
n = 200 , left side = 4.85201986681627e-3
          1/n^(3/10) = 2.04028577336837e-1
          difference = 1.99176557470021e-1
n = 500 , left side = 1.95265780521137e-3
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.53039240949622e-1

```

$\cos(x)$

```

n = 10 , left side = 1.15283010872480e-1
          1/n^(3/10) = 5.01187233627272e-1
          difference = 3.85904222754792e-1
n = 20 , left side = 5.36357377250527e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.53454793811852e-1
n = 50 , left side = 2.03721756047667e-2

```

```

1/n^(3/10) = 3.09249494710992e-1
difference = 2.88877319106225e-1
n = 100 , left side = 9.99650884011449e-3
1/n^(3/10) = 2.51188643150958e-1
difference = 2.41192134310844e-1
n = 200 , left side = 4.95003918172576e-3
1/n^(3/10) = 2.04028577336837e-1
difference = 1.99078538155111e-1
n = 500 , left side = 1.96834138039337e-3
1/n^(3/10) = 1.54991898754834e-1
difference = 1.53023557374440e-1

```

-----  
 $x_0 = 1/4\pi$ , Power = 3/10, lamda = 1, q = 1/2  
-----

```

sin(x)
n = 10 , left side = 3.37717704676069e-2
1/n^(3/10) = 5.01187233627272e-1
difference = 4.67415463159665e-1
n = 20 , left side = 2.07753148869368e-2
1/n^(3/10) = 4.07090531536904e-1
difference = 3.86315216649968e-1
n = 50 , left side = 9.21511967883237e-3
1/n^(3/10) = 3.09249494710992e-1
difference = 3.00034375032159e-1
n = 100 , left side = 4.75529633802119e-3
1/n^(3/10) = 2.51188643150958e-1
difference = 2.46433346812937e-1
n = 200 , left side = 2.41425898359438e-3
1/n^(3/10) = 2.04028577336837e-1
difference = 2.01614318353243e-1
n = 500 , left side = 9.74447341997475e-4
1/n^(3/10) = 1.54991898754834e-1

```

difference = 1.54017451412836e-1

$\cos(x)$

n = 10 , left side = 6.24222476166081e-2  
1/n^(3/10) = 5.01187233627272e-1  
difference = 4.38764986010664e-1  
n = 20 , left side = 2.80065121964508e-2  
1/n^(3/10) = 4.07090531536904e-1  
difference = 3.79084019340454e-1  
n = 50 , left side = 1.03752156077472e-2  
1/n^(3/10) = 3.09249494710992e-1  
difference = 2.98874279103244e-1  
n = 100 , left side = 5.04543146629366e-3  
1/n^(3/10) = 2.51188643150958e-1  
difference = 2.46143211684664e-1  
n = 200 , left side = 2.48679971416932e-3  
1/n^(3/10) = 2.04028577336837e-1  
difference = 2.01541777622668e-1  
n = 500 , left side = 9.86054169944905e-4  
1/n^(3/10) = 1.54991898754834e-1  
difference = 1.54005844584889e-1

-----  
x0 = 1/4\*pi, Power = 3/10, lamda = 1, q = 1  
-----

$\sin(x)$

n = 10 , left side = 1.26576588370484e-2  
1/n^(3/10) = 5.01187233627272e-1  
difference = 4.88529574790224e-1  
n = 20 , left side = 3.19289527212963e-3  
1/n^(3/10) = 4.07090531536904e-1  
difference = 4.03897636264775e-1

```

n = 50 , left side = 5.12151444058695e-4
          1/n^(3/10) = 3.09249494710992e-1
          difference = 3.08737343266933e-1
n = 100 , left side = 1.28084179052412e-4
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.51060558971906e-1
n = 200 , left side = 3.20238618124469e-5
          1/n^(3/10) = 2.04028577336837e-1
          difference = 2.03996553475025e-1
n = 500 , left side = 5.12400106755795e-6
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.54986774753766e-1

```

$\cos(x)$

```

n = 10 , left side = 1.26576548275704e-2
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.88529578799702e-1
n = 20 , left side = 3.19289294996883e-3
          1/n^(3/10) = 4.07090531536904e-1
          difference = 4.03897638586936e-1
n = 50 , left side = 5.12152389308462e-4
          1/n^(3/10) = 3.09249494710992e-1
          difference = 3.08737342321683e-1
n = 100 , left side = 1.28084061290279e-4
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.51060559089668e-1
n = 200 , left side = 3.20239758673235e-5
          1/n^(3/10) = 2.04028577336837e-1
          difference = 2.03996553360970e-1
n = 500 , left side = 5.12391080242924e-6
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.54986774844031e-1

```

-----

$x_0 = 1/4\pi$ , Power = 1/2, lamda = 1/4, q = 1/4

---

$\sin(x)$

n = 10 , left side = 6.14723251420852e-2  
1/n^(1/2) = 3.16227766016838e-1  
difference = 2.54755440874753e-1  
n = 20 , left side = 1.11294566010310e-1  
1/n^(1/2) = 2.23606797749979e-1  
difference = 1.12312231739669e-1  
n = 50 , left side = 6.57022757028688e-2  
1/n^(1/2) = 1.41421356237310e-1  
difference = 7.57190805344407e-2  
n = 100 , left side = 3.61332770545404e-2  
1/n^(1/2) = 1.00000000000000e-1  
difference = 6.38667229454596e-2  
n = 200 , left side = 1.88501016814132e-2  
1/n^(1/2) = 7.07106781186548e-2  
difference = 5.18605764372415e-2  
n = 500 , left side = 7.72268598453840e-3  
1/n^(1/2) = 4.47213595499958e-2  
difference = 3.69986735654574e-2

$\cos(x)$

n = 10 , left side = 5.17973276214348e-1  
1/n^(1/2) = 3.16227766016838e-1  
difference = -2.01745510197510e-1  
n = 20 , left side = 2.51295039601676e-1  
1/n^(1/2) = 2.23606797749979e-1  
difference = -2.76882418516967e-2  
n = 50 , left side = 8.91716716056313e-2  
1/n^(1/2) = 1.41421356237310e-1  
difference = 5.22496846316782e-2  
n = 100 , left side = 4.20399787268633e-2

```

1/n^(1/2) = 1.000000000000000e-1
difference = 5.79600212731367e-2
n = 200 , left side = 2.03292531654996e-2
1/n^(1/2) = 7.07106781186548e-2
difference = 5.03814249531551e-2
n = 500 , left side = 7.95946134048608e-3
1/n^(1/2) = 4.47213595499958e-2
difference = 3.67618982095097e-2

```

-----  
 $x_0 = 1/4\pi$ , Power = 1/2, lamda = 1/4, q = 1/2  
 -----

```

sin(x)
n = 10 , left side = 2.25818738884073e-2
1/n^(1/2) = 3.16227766016838e-1
difference = 2.93645892128431e-1
n = 20 , left side = 4.04453908761683e-2
1/n^(1/2) = 2.23606797749979e-1
difference = 1.83161406873811e-1
n = 50 , left side = 3.02663846427300e-2
1/n^(1/2) = 1.41421356237310e-1
difference = 1.11154971594579e-1
n = 100 , left side = 1.74104170545998e-2
1/n^(1/2) = 1.00000000000000e-1
difference = 8.25895829454002e-2
n = 200 , left side = 9.25989196858323e-3
1/n^(1/2) = 7.07106781186548e-2
difference = 6.14507861500715e-2
n = 500 , left side = 3.83481978962907e-3
1/n^(1/2) = 4.47213595499958e-2
difference = 4.08865397603667e-2

```

```

cos(x)

```



```

n = 10 , left side = 3.22248031460382e-1
          1/n^(1/2) = 3.16227766016838e-1
          difference = -6.02026544354439e-3
n = 20 , left side = 1.42602604325762e-1
          1/n^(1/2) = 2.23606797749979e-1
          difference = 8.10041934242166e-2
n = 50 , left side = 4.72897971848895e-2
          1/n^(1/2) = 1.41421356237310e-1
          difference = 9.41315590524200e-2
n = 100 , left side = 2.16912390801813e-2
          1/n^(1/2) = 1.00000000000000e-1
          difference = 7.83087609198187e-2
n = 200 , left side = 1.03316679895296e-2
          1/n^(1/2) = 7.07106781186548e-2
          difference = 6.03790101291252e-2
n = 500 , left side = 4.00637442698670e-3
          1/n^(1/2) = 4.47213595499958e-2
          difference = 4.07149851230091e-2

```

-----  
 $x_0 = 1/4\pi$ , Power = 1/2, lamda = 1/4, q = 1  
 -----

$\sin(x)$

```

n = 10 , left side = 1.55169425547731e-1
          1/n^(1/2) = 3.16227766016838e-1
          difference = 1.61058340469107e-1
n = 20 , left side = 4.47376351803206e-2
          1/n^(1/2) = 2.23606797749979e-1
          difference = 1.78869162569658e-1
n = 50 , left side = 7.43627371125710e-3
          1/n^(1/2) = 1.41421356237310e-1
          difference = 1.33985082526052e-1
n = 100 , left side = 1.86936162198503e-3

```

```

1/n^(1/2) = 1.000000000000000e-1
difference = 9.81306383780150e-2
n = 200 , left side = 4.67987750301657e-4
1/n^(1/2) = 7.07106781186548e-2
difference = 7.02426903683531e-2
n = 500 , left side = 7.49070874977997e-5
1/n^(1/2) = 4.47213595499958e-2
difference = 4.46464524624980e-2

```

$\cos(x)$

```

n = 10 , left side = 1.53728257318856e-1
1/n^(1/2) = 3.16227766016838e-1
difference = 1.62499508697982e-1
n = 20 , left side = 4.47310387031025e-2
1/n^(1/2) = 2.23606797749979e-1
difference = 1.78875759046876e-1
n = 50 , left side = 7.43627371112354e-3
1/n^(1/2) = 1.41421356237310e-1
difference = 1.33985082526186e-1
n = 100 , left side = 1.86936162198525e-3
1/n^(1/2) = 1.000000000000000e-1
difference = 9.81306383780148e-2
n = 200 , left side = 4.67987750301324e-4
1/n^(1/2) = 7.07106781186548e-2
difference = 7.02426903683534e-2
n = 500 , left side = 7.49070874974667e-5
1/n^(1/2) = 4.47213595499958e-2
difference = 4.46464524624983e-2

```

---

$x_0 = 1/4\pi$ , Power = 1/2, lamda = 1/2, q = 1/4

---

$\sin(x)$

$n = 10$  , left side = 1.10269377456684e-1  
 $1/n^{(1/2)} = 3.16227766016838e-1$   
difference = 2.05958388560154e-1  
 $n = 20$  , left side = 7.76237576737794e-2  
 $1/n^{(1/2)} = 2.23606797749979e-1$   
difference = 1.45983040076200e-1  
 $n = 50$  , left side = 3.60961153613111e-2  
 $1/n^{(1/2)} = 1.41421356237310e-1$   
difference = 1.05325240875998e-1  
 $n = 100$  , left side = 1.88410272392819e-2  
 $1/n^{(1/2)} = 1.00000000000000e-1$   
difference = 8.11589727607181e-2  
 $n = 200$  , left side = 9.61343382830959e-3  
 $1/n^{(1/2)} = 7.07106781186548e-2$   
difference = 6.10972442903452e-2  
 $n = 500$  , left side = 3.89095422715502e-3  
 $1/n^{(1/2)} = 4.47213595499958e-2$   
difference = 4.08304053228408e-2

$$\cos(x)$$

$n = 10$  , left side = 2.51869405006841e-1  
 $1/n^{(1/2)} = 3.16227766016838e-1$   
difference = 6.43583610099970e-2  
 $n = 20$  , left side = 1.14542456854608e-1  
 $1/n^{(1/2)} = 2.23606797749979e-1$   
difference = 1.09064340895371e-1  
 $n = 50$  , left side = 4.20732317898761e-2  
 $1/n^{(1/2)} = 1.41421356237310e-1$   
difference = 9.93481244474334e-2  
 $n = 100$  , left side = 2.03378378667143e-2  
 $1/n^{(1/2)} = 1.00000000000000e-1$   
difference = 7.96621621332857e-2  
 $n = 200$  , left side = 9.98779497231439e-3  
 $1/n^{(1/2)} = 7.07106781186548e-2$   
difference = 6.07228831463404e-2

```

n = 500 , left side = 3.95085911348825e-3
          1/n^(1/2) = 4.47213595499958e-2
          difference = 4.07705004365075e-2

```

```

-----
x0 = 1/4*pi, Power = 1/2, lamda = 1/2,  q = 1/2
-----

```

$\sin(x)$

```

n = 10 , left side = 3.95100600139322e-2
          1/n^(1/2) = 3.16227766016838e-1
          difference = 2.76717706002906e-1
n = 20 , left side = 3.46988342396720e-2
          1/n^(1/2) = 2.23606797749979e-1
          difference = 1.88907963510307e-1
n = 50 , left side = 1.73741914965689e-2
          1/n^(1/2) = 1.41421356237310e-1
          difference = 1.24047164740741e-1
n = 100 , left side = 9.25093740382410e-3
          1/n^(1/2) = 1.00000000000000e-1
          difference = 9.07490625961759e-2
n = 200 , left side = 4.76419447265519e-3
          1/n^(1/2) = 7.07106781186548e-2
          difference = 6.59464836459996e-2
n = 500 , left side = 1.93866173914448e-3
          1/n^(1/2) = 4.47213595499958e-2
          difference = 4.27826978108513e-2

```

$\cos(x)$

```

n = 10 , left side = 1.43310623580410e-1
          1/n^(1/2) = 3.16227766016838e-1
          difference = 1.72917142436428e-1
n = 20 , left side = 6.16155530779093e-2

```

```

1/n^(1/2) = 2.23606797749979e-1
difference = 1.61991244672070e-1
n = 50 , left side = 2.17255095716977e-2
1/n^(1/2) = 1.41421356237310e-1
difference = 1.19695846665612e-1
n = 100 , left side = 1.03403776602990e-2
1/n^(1/2) = 1.00000000000000e-1
difference = 8.96596223397010e-2
n = 200 , left side = 5.03665536910614e-3
1/n^(1/2) = 7.07106781186548e-2
difference = 6.56740227495486e-2
n = 500 , left side = 1.98226000171697e-3
1/n^(1/2) = 4.47213595499958e-2
difference = 4.27390995482788e-2

```

-----  
x0 = 1/4\*pi, Power = 1/2, lamda = 1/2, q = 1  
-----

```

sin(x)
n = 10 , left side = 4.55658979518567e-2
1/n^(1/2) = 3.16227766016838e-1
difference = 2.70661868064981e-1
n = 20 , left side = 1.17886898348858e-2
1/n^(1/2) = 2.23606797749979e-1
difference = 2.11818107915093e-1
n = 50 , left side = 1.90462319911511e-3
1/n^(1/2) = 1.41421356237310e-1
difference = 1.39516733038194e-1
n = 100 , left side = 4.76820716817206e-4
1/n^(1/2) = 1.00000000000000e-1
difference = 9.95231792831828e-2
n = 200 , left side = 1.19246801639439e-4
1/n^(1/2) = 7.07106781186548e-2

```

```

        difference = 7.05914313170153e-2
n = 500 , left side = 1.90813536953272e-5
        1/n^(1/2) = 4.47213595499958e-2
        difference = 4.47022781963005e-2

```

$\cos(x)$

```

n = 10 , left side = 4.55601836086841e-2
        1/n^(1/2) = 3.16227766016838e-1
        difference = 2.70667582408154e-1
n = 20 , left side = 1.17886897702850e-2
        1/n^(1/2) = 2.23606797749979e-1
        difference = 2.11818107979694e-1
n = 50 , left side = 1.90462319911522e-3
        1/n^(1/2) = 1.41421356237310e-1
        difference = 1.39516733038194e-1
n = 100 , left side = 4.76820716817428e-4
        1/n^(1/2) = 1.00000000000000e-1
        difference = 9.95231792831826e-2
n = 200 , left side = 1.19246801639661e-4
        1/n^(1/2) = 7.07106781186548e-2
        difference = 7.05914313170151e-2
n = 500 , left side = 1.90813536955492e-5
        1/n^(1/2) = 4.47213595499958e-2
        difference = 4.47022781963002e-2

```

-----  
 $x_0 = 1/4\pi$ , Power = 1/2, lamda = 1, q = 1/4  
 -----

$\sin(x)$

```

n = 10 , left side = 7.66430508778088e-2
        1/n^(1/2) = 3.16227766016838e-1
        difference = 2.39584715139029e-1

```

```

n = 20 , left side = 4.38693273663758e-2
          1/n^(1/2) = 2.23606797749979e-1
          difference = 1.79737470383603e-1
n = 50 , left side = 1.88047297835470e-2
          1/n^(1/2) = 1.41421356237310e-1
          difference = 1.22616626453763e-1
n = 100 , left side = 9.60447473250958e-3
          1/n^(1/2) = 1.00000000000000e-1
          difference = 9.03955252674904e-2
n = 200 , left side = 4.85201986681627e-3
          1/n^(1/2) = 7.07106781186548e-2
          difference = 6.58586582518385e-2
n = 500 , left side = 1.95265780521137e-3
          1/n^(1/2) = 4.47213595499958e-2
          difference = 4.27687017447844e-2

```

$\cos(x)$

```

n = 10 , left side = 1.15283010872480e-1
          1/n^(1/2) = 3.16227766016838e-1
          difference = 2.00944755144358e-1
n = 20 , left side = 5.36357377250527e-2
          1/n^(1/2) = 2.23606797749979e-1
          difference = 1.69971060024926e-1
n = 50 , left side = 2.03721756047667e-2
          1/n^(1/2) = 1.41421356237310e-1
          difference = 1.21049180632543e-1
n = 100 , left side = 9.99650884011449e-3
          1/n^(1/2) = 1.00000000000000e-1
          difference = 9.00034911598855e-2
n = 200 , left side = 4.95003918172576e-3
          1/n^(1/2) = 7.07106781186548e-2
          difference = 6.57606389369290e-2
n = 500 , left side = 1.96834138039337e-3
          1/n^(1/2) = 4.47213595499958e-2
          difference = 4.27530181696024e-2

```

-----  
 $x_0 = 1/4\pi$ , Power = 1/2, lamda = 1, q = 1/2  
 -----

$\sin(x)$

```

n = 10 , left side = 3.37717704676069e-2
          1/n^(1/2) = 3.16227766016838e-1
          difference = 2.82455995549231e-1
n = 20 , left side = 2.07753148869368e-2
          1/n^(1/2) = 2.23606797749979e-1
          difference = 2.02831482863042e-1
n = 50 , left side = 9.21511967883237e-3
          1/n^(1/2) = 1.41421356237310e-1
          difference = 1.32206236558477e-1
n = 100 , left side = 4.75529633802119e-3
          1/n^(1/2) = 1.00000000000000e-1
          difference = 9.52447036619788e-2
n = 200 , left side = 2.41425898359438e-3
          1/n^(1/2) = 7.07106781186548e-2
          difference = 6.82964191350604e-2
n = 500 , left side = 9.74447341997475e-4
          1/n^(1/2) = 4.47213595499958e-2
          difference = 4.37469122079983e-2

```

$\cos(x)$

```

n = 10 , left side = 6.24222476166081e-2
          1/n^(1/2) = 3.16227766016838e-1
          difference = 2.53805518400230e-1
n = 20 , left side = 2.80065121964508e-2
          1/n^(1/2) = 2.23606797749979e-1
          difference = 1.95600285553528e-1
n = 50 , left side = 1.03752156077472e-2

```



```

1/n^(1/2) = 1.41421356237310e-1
difference = 1.31046140629562e-1
n = 100 , left side = 5.04543146629366e-3
1/n^(1/2) = 1.00000000000000e-1
difference = 9.49545685337063e-2
n = 200 , left side = 2.48679971416932e-3
1/n^(1/2) = 7.07106781186548e-2
difference = 6.82238784044854e-2
n = 500 , left side = 9.86054169944905e-4
1/n^(1/2) = 4.47213595499958e-2
difference = 4.37353053800509e-2

```

-----  
 $x_0 = 1/4\pi$ , Power = 1/2, lamda = 1, q = 1  
 -----

$\sin(x)$

```

n = 10 , left side = 1.26576588370484e-2
1/n^(1/2) = 3.16227766016838e-1
difference = 3.03570107179790e-1
n = 20 , left side = 3.19289527212963e-3
1/n^(1/2) = 2.23606797749979e-1
difference = 2.20413902477849e-1
n = 50 , left side = 5.12151444058695e-4
1/n^(1/2) = 1.41421356237310e-1
difference = 1.40909204793251e-1
n = 100 , left side = 1.28084179052412e-4
1/n^(1/2) = 1.00000000000000e-1
difference = 9.98719158209476e-2
n = 200 , left side = 3.20238618124469e-5
1/n^(1/2) = 7.07106781186548e-2
difference = 7.06786542568423e-2
n = 500 , left side = 5.12400106755795e-6
1/n^(1/2) = 4.47213595499958e-2

```

difference = 4.47162355489282e-2

$\cos(x)$

n = 10 , left side = 1.26576548275704e-2  
1/n^(1/2) = 3.16227766016838e-1  
difference = 3.03570111189268e-1  
n = 20 , left side = 3.19289294996883e-3  
1/n^(1/2) = 2.23606797749979e-1  
difference = 2.20413904800010e-1  
n = 50 , left side = 5.12152389308462e-4  
1/n^(1/2) = 1.41421356237310e-1  
difference = 1.40909203848001e-1  
n = 100 , left side = 1.28084061290279e-4  
1/n^(1/2) = 1.00000000000000e-1  
difference = 9.98719159387097e-2  
n = 200 , left side = 3.20239758673235e-5  
1/n^(1/2) = 7.07106781186548e-2  
difference = 7.06786541427874e-2  
n = 500 , left side = 5.12391080242924e-6  
1/n^(1/2) = 4.47213595499958e-2  
difference = 4.47162356391934e-2

-----  
x0 = 1/4\*pi, Power = 7/10, lamda = 1/4, q = 1/4  
-----

$\sin(x)$

n = 10 , left side = 6.14723251420852e-2  
1/n^(7/10) = 1.99526231496888e-1  
difference = 1.38053906354803e-1  
n = 20 , left side = 1.11294566010310e-1  
1/n^(7/10) = 1.22822802611579e-1  
difference = 1.15282366012690e-2

```

n = 50 , left side = 6.57022757028688e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = -1.02957504513304e-3
n = 100 , left side = 3.61332770545404e-2
          1/n^(7/10) = 3.98107170553497e-2
          difference = 3.67744000080934e-3
n = 200 , left side = 1.88501016814132e-2
          1/n^(7/10) = 2.45063709469745e-2
          difference = 5.65626926556129e-3
n = 500 , left side = 7.72268598453840e-3
          1/n^(7/10) = 1.29039002429643e-2
          difference = 5.18121425842592e-3

```

$\cos(x)$

```

n = 10 , left side = 5.17973276214348e-1
          1/n^(7/10) = 1.99526231496888e-1
          difference = -3.18447044717460e-1
n = 20 , left side = 2.51295039601676e-1
          1/n^(7/10) = 1.22822802611579e-1
          difference = -1.28472236990097e-1
n = 50 , left side = 8.91716716056313e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = -2.44989709478956e-2
n = 100 , left side = 4.20399787268633e-2
          1/n^(7/10) = 3.98107170553497e-2
          difference = -2.22926167151354e-3
n = 200 , left side = 2.03292531654996e-2
          1/n^(7/10) = 2.45063709469745e-2
          difference = 4.17711778147490e-3
n = 500 , left side = 7.95946134048608e-3
          1/n^(7/10) = 1.29039002429643e-2
          difference = 4.94443890247824e-3

```

-----

$x_0 = 1/4\pi$ , Power = 7/10, lamda = 1/4, q = 1/2

---

$\sin(x)$

n = 10 , left side = 2.25818738884073e-2  
1/n^(7/10) = 1.99526231496888e-1  
difference = 1.76944357608481e-1  
n = 20 , left side = 4.04453908761683e-2  
1/n^(7/10) = 1.22822802611579e-1  
difference = 8.23774117354108e-2  
n = 50 , left side = 3.02663846427300e-2  
1/n^(7/10) = 6.46727006577358e-2  
difference = 3.44063160150057e-2  
n = 100 , left side = 1.74104170545998e-2  
1/n^(7/10) = 3.98107170553497e-2  
difference = 2.24003000007500e-2  
n = 200 , left side = 9.25989196858323e-3  
1/n^(7/10) = 2.45063709469745e-2  
difference = 1.52464789783913e-2  
n = 500 , left side = 3.83481978962907e-3  
1/n^(7/10) = 1.29039002429643e-2  
difference = 9.06908045333525e-3

$\cos(x)$

n = 10 , left side = 3.22248031460382e-1  
1/n^(7/10) = 1.99526231496888e-1  
difference = -1.22721799963494e-1  
n = 20 , left side = 1.42602604325762e-1  
1/n^(7/10) = 1.22822802611579e-1  
difference = -1.97798017141833e-2  
n = 50 , left side = 4.72897971848895e-2  
1/n^(7/10) = 6.46727006577358e-2  
difference = 1.73829034728463e-2  
n = 100 , left side = 2.16912390801813e-2

```

1/n^(7/10) = 3.98107170553497e-2
difference = 1.81194779751684e-2
n = 200 , left side = 1.03316679895296e-2
1/n^(7/10) = 2.45063709469745e-2
difference = 1.41747029574449e-2
n = 500 , left side = 4.00637442698670e-3
1/n^(7/10) = 1.29039002429643e-2
difference = 8.89752581597762e-3

```

---

```

x0 = 1/4*pi, Power = 7/10, lamda = 1/4, q = 1

```

---

$\sin(x)$

```

n = 10 , left side = 1.55169425547731e-1
1/n^(7/10) = 1.99526231496888e-1
difference = 4.43568059491574e-2
n = 20 , left side = 4.47376351803206e-2
1/n^(7/10) = 1.22822802611579e-1
difference = 7.80851674312585e-2
n = 50 , left side = 7.43627371125710e-3
1/n^(7/10) = 6.46727006577358e-2
difference = 5.72364269464787e-2
n = 100 , left side = 1.86936162198503e-3
1/n^(7/10) = 3.98107170553497e-2
difference = 3.79413554333647e-2
n = 200 , left side = 4.67987750301657e-4
1/n^(7/10) = 2.45063709469745e-2
difference = 2.40383831966728e-2
n = 500 , left side = 7.49070874977997e-5
1/n^(7/10) = 1.29039002429643e-2
difference = 1.28289931554665e-2

```

$\cos(x)$

```

n = 10 , left side = 1.53728257318856e-1
          1/n^(7/10) = 1.99526231496888e-1
          difference = 4.57979741780322e-2
n = 20 , left side = 4.47310387031025e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 7.80917639084766e-2
n = 50 , left side = 7.43627371112354e-3
          1/n^(7/10) = 6.46727006577358e-2
          difference = 5.72364269466122e-2
n = 100 , left side = 1.86936162198525e-3
          1/n^(7/10) = 3.98107170553497e-2
          difference = 3.79413554333645e-2
n = 200 , left side = 4.67987750301324e-4
          1/n^(7/10) = 2.45063709469745e-2
          difference = 2.40383831966732e-2
n = 500 , left side = 7.49070874974667e-5
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.28289931554669e-2

```

-----  
 $x_0 = 1/4\pi$ , Power = 7/10, lamda = 1/2, q = 1/4  
 -----

$\sin(x)$

```

n = 10 , left side = 1.10269377456684e-1
          1/n^(7/10) = 1.99526231496888e-1
          difference = 8.92568540402037e-2
n = 20 , left side = 7.76237576737794e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 4.51990449377997e-2
n = 50 , left side = 3.60961153613111e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = 2.85765852964247e-2
n = 100 , left side = 1.88410272392819e-2

```

```

1/n^(7/10) = 3.98107170553497e-2
difference = 2.09696898160678e-2
n = 200 , left side = 9.61343382830959e-3
1/n^(7/10) = 2.45063709469745e-2
difference = 1.48929371186649e-2
n = 500 , left side = 3.89095422715502e-3
1/n^(7/10) = 1.29039002429643e-2
difference = 9.01294601580930e-3

```

$\cos(x)$

```

n = 10 , left side = 2.51869405006841e-1
1/n^(7/10) = 1.99526231496888e-1
difference = -5.23431735099530e-2
n = 20 , left side = 1.14542456854608e-1
1/n^(7/10) = 1.22822802611579e-1
difference = 8.28034575697098e-3
n = 50 , left side = 4.20732317898761e-2
1/n^(7/10) = 6.46727006577358e-2
difference = 2.25994688678597e-2
n = 100 , left side = 2.03378378667143e-2
1/n^(7/10) = 3.98107170553497e-2
difference = 1.94728791886355e-2
n = 200 , left side = 9.98779497231439e-3
1/n^(7/10) = 2.45063709469745e-2
difference = 1.45185759746601e-2
n = 500 , left side = 3.95085911348825e-3
1/n^(7/10) = 1.29039002429643e-2
difference = 8.95304112947608e-3

```

-----  
 $x_0 = 1/4\pi$ , Power = 7/10, lamda = 1/2, q = 1/2  
 -----

$\sin(x)$

$n = 10$  , left side = 3.95100600139322e-2  
 $1/n^{(7/10)} = 1.99526231496888e-1$   
difference = 1.60016171482956e-1  
 $n = 20$  , left side = 3.46988342396720e-2  
 $1/n^{(7/10)} = 1.22822802611579e-1$   
difference = 8.81239683719070e-2  
 $n = 50$  , left side = 1.73741914965689e-2  
 $1/n^{(7/10)} = 6.46727006577358e-2$   
difference = 4.72985091611668e-2  
 $n = 100$  , left side = 9.25093740382410e-3  
 $1/n^{(7/10)} = 3.98107170553497e-2$   
difference = 3.05597796515256e-2  
 $n = 200$  , left side = 4.76419447265519e-3  
 $1/n^{(7/10)} = 2.45063709469745e-2$   
difference = 1.97421764743193e-2  
 $n = 500$  , left side = 1.93866173914448e-3  
 $1/n^{(7/10)} = 1.29039002429643e-2$   
difference = 1.09652385038198e-2

$$\cos(x)$$

$n = 10$  , left side = 1.43310623580410e-1  
 $1/n^{(7/10)} = 1.99526231496888e-1$   
difference = 5.62156079164781e-2  
 $n = 20$  , left side = 6.16155530779093e-2  
 $1/n^{(7/10)} = 1.22822802611579e-1$   
difference = 6.12072495336697e-2  
 $n = 50$  , left side = 2.17255095716977e-2  
 $1/n^{(7/10)} = 6.46727006577358e-2$   
difference = 4.29471910860380e-2  
 $n = 100$  , left side = 1.03403776602990e-2  
 $1/n^{(7/10)} = 3.98107170553497e-2$   
difference = 2.94703393950507e-2  
 $n = 200$  , left side = 5.03665536910614e-3  
 $1/n^{(7/10)} = 2.45063709469745e-2$   
difference = 1.94697155778684e-2



```

n = 500 , left side = 1.98226000171697e-3
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.09216402412474e-2

```

```

-----
x0 = 1/4*pi, Power = 7/10, lamda = 1/2,  q = 1
-----

```

$\sin(x)$

```

n = 10 , left side = 4.55658979518567e-2
          1/n^(7/10) = 1.99526231496888e-1
          difference = 1.53960333545031e-1
n = 20 , left side = 1.17886898348858e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 1.11034112776693e-1
n = 50 , left side = 1.90462319911511e-3
          1/n^(7/10) = 6.46727006577358e-2
          difference = 6.27680774586206e-2
n = 100 , left side = 4.76820716817206e-4
          1/n^(7/10) = 3.98107170553497e-2
          difference = 3.93338963385325e-2
n = 200 , left side = 1.19246801639439e-4
          1/n^(7/10) = 2.45063709469745e-2
          difference = 2.43871241453351e-2
n = 500 , left side = 1.90813536953272e-5
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.28848188892690e-2

```

$\cos(x)$

```

n = 10 , left side = 4.55601836086841e-2
          1/n^(7/10) = 1.99526231496888e-1
          difference = 1.53966047888204e-1
n = 20 , left side = 1.17886897702850e-2

```

```

1/n^(7/10) = 1.22822802611579e-1
difference = 1.11034112841294e-1
n = 50 , left side = 1.90462319911522e-3
1/n^(7/10) = 6.46727006577358e-2
difference = 6.27680774586205e-2
n = 100 , left side = 4.76820716817428e-4
1/n^(7/10) = 3.98107170553497e-2
difference = 3.93338963385323e-2
n = 200 , left side = 1.19246801639661e-4
1/n^(7/10) = 2.45063709469745e-2
difference = 2.43871241453348e-2
n = 500 , left side = 1.90813536955492e-5
1/n^(7/10) = 1.29039002429643e-2
difference = 1.28848188892688e-2

```

-----  
x0 = 1/4\*pi, Power = 7/10, lamda = 1, q = 1/4  
-----

```

sin(x)

n = 10 , left side = 7.66430508778088e-2
1/n^(7/10) = 1.99526231496888e-1
difference = 1.22883180619079e-1
n = 20 , left side = 4.38693273663758e-2
1/n^(7/10) = 1.22822802611579e-1
difference = 7.89534752452032e-2
n = 50 , left side = 1.88047297835470e-2
1/n^(7/10) = 6.46727006577358e-2
difference = 4.58679708741888e-2
n = 100 , left side = 9.60447473250958e-3
1/n^(7/10) = 3.98107170553497e-2
difference = 3.02062423228402e-2
n = 200 , left side = 4.85201986681627e-3
1/n^(7/10) = 2.45063709469745e-2

```

```

        difference = 1.96543510801582e-2
n = 500 , left side = 1.95265780521137e-3
        1/n^(7/10) = 1.29039002429643e-2
        difference = 1.09512424377530e-2

```

$\cos(x)$

```

n = 10 , left side = 1.15283010872480e-1
        1/n^(7/10) = 1.99526231496888e-1
        difference = 8.42432206244081e-2
n = 20 , left side = 5.36357377250527e-2
        1/n^(7/10) = 1.22822802611579e-1
        difference = 6.91870648865263e-2
n = 50 , left side = 2.03721756047667e-2
        1/n^(7/10) = 6.46727006577358e-2
        difference = 4.43005250529691e-2
n = 100 , left side = 9.99650884011449e-3
        1/n^(7/10) = 3.98107170553497e-2
        difference = 2.98142082152352e-2
n = 200 , left side = 4.95003918172576e-3
        1/n^(7/10) = 2.45063709469745e-2
        difference = 1.95563317652487e-2
n = 500 , left side = 1.96834138039337e-3
        1/n^(7/10) = 1.29039002429643e-2
        difference = 1.09355588625710e-2

```

---

$x_0 = 1/4\pi$ , Power = 7/10, lamda = 1, q = 1/2

---

$\sin(x)$

```

n = 10 , left side = 3.37717704676069e-2
        1/n^(7/10) = 1.99526231496888e-1
        difference = 1.65754461029281e-1

```

$n = 20$  , left side =  $2.07753148869368e-2$   
 $1/n^{(7/10)} = 1.22822802611579e-1$   
difference =  $1.02047487724642e-1$   
 $n = 50$  , left side =  $9.21511967883237e-3$   
 $1/n^{(7/10)} = 6.46727006577358e-2$   
difference =  $5.54575809789034e-2$   
 $n = 100$  , left side =  $4.75529633802119e-3$   
 $1/n^{(7/10)} = 3.98107170553497e-2$   
difference =  $3.50554207173285e-2$   
 $n = 200$  , left side =  $2.41425898359438e-3$   
 $1/n^{(7/10)} = 2.45063709469745e-2$   
difference =  $2.20921119633801e-2$   
 $n = 500$  , left side =  $9.74447341997475e-4$   
 $1/n^{(7/10)} = 1.29039002429643e-2$   
difference =  $1.19294529009668e-2$

$\cos(x)$

$n = 10$  , left side =  $6.24222476166081e-2$   
 $1/n^{(7/10)} = 1.99526231496888e-1$   
difference =  $1.37103983880280e-1$   
 $n = 20$  , left side =  $2.80065121964508e-2$   
 $1/n^{(7/10)} = 1.22822802611579e-1$   
difference =  $9.48162904151283e-2$   
 $n = 50$  , left side =  $1.03752156077472e-2$   
 $1/n^{(7/10)} = 6.46727006577358e-2$   
difference =  $5.42974850499885e-2$   
 $n = 100$  , left side =  $5.04543146629366e-3$   
 $1/n^{(7/10)} = 3.98107170553497e-2$   
difference =  $3.47652855890561e-2$   
 $n = 200$  , left side =  $2.48679971416932e-3$   
 $1/n^{(7/10)} = 2.45063709469745e-2$   
difference =  $2.20195712328052e-2$   
 $n = 500$  , left side =  $9.86054169944905e-4$   
 $1/n^{(7/10)} = 1.29039002429643e-2$   
difference =  $1.19178460730194e-2$

-----  
 $x_0 = 1/4\pi$ , Power = 7/10, lamda = 1, q = 1  
 -----

$\sin(x)$

```

n = 10 , left side = 1.26576588370484e-2
          1/n^(7/10) = 1.99526231496888e-1
          difference = 1.86868572659840e-1
n = 20 , left side = 3.19289527212963e-3
          1/n^(7/10) = 1.22822802611579e-1
          difference = 1.19629907339449e-1
n = 50 , left side = 5.12151444058695e-4
          1/n^(7/10) = 6.46727006577358e-2
          difference = 6.41605492136771e-2
n = 100 , left side = 1.28084179052412e-4
          1/n^(7/10) = 3.98107170553497e-2
          difference = 3.96826328762973e-2
n = 200 , left side = 3.20238618124469e-5
          1/n^(7/10) = 2.45063709469745e-2
          difference = 2.44743470851621e-2
n = 500 , left side = 5.12400106755795e-6
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.28987762418968e-2

```

$\cos(x)$

```

n = 10 , left side = 1.26576548275704e-2
          1/n^(7/10) = 1.99526231496888e-1
          difference = 1.86868576669318e-1
n = 20 , left side = 3.19289294996883e-3
          1/n^(7/10) = 1.22822802611579e-1
          difference = 1.19629909661610e-1
n = 50 , left side = 5.12152389308462e-4

```

```

1/n^(7/10) = 6.46727006577358e-2
difference = 6.41605482684273e-2
n = 100 , left side = 1.28084061290279e-4
1/n^(7/10) = 3.98107170553497e-2
difference = 3.96826329940595e-2
n = 200 , left side = 3.20239758673235e-5
1/n^(7/10) = 2.45063709469745e-2
difference = 2.44743469711072e-2
n = 500 , left side = 5.12391080242924e-6
1/n^(7/10) = 1.29039002429643e-2
difference = 1.28987763321619e-2

```

-----  
 $x_0 = 1/2\pi$ , Power = 3/10, lamda = 1/4, q = 1/4  
 -----

$\sin(x)$

```

n = 10 , left side = 2.59670416080878e-1
1/n^(3/10) = 5.01187233627272e-1
difference = 2.41516817546394e-1
n = 20 , left side = 9.72188312719504e-2
1/n^(3/10) = 4.07090531536904e-1
difference = 3.09871700264954e-1
n = 50 , left side = 1.65953574461681e-2
1/n^(3/10) = 3.09249494710992e-1
difference = 2.92654137264824e-1
n = 100 , left side = 4.17666880694489e-3
1/n^(3/10) = 2.51188643150958e-1
difference = 2.47011974344013e-1
n = 200 , left side = 1.04591804479937e-3
1/n^(3/10) = 2.04028577336837e-1
difference = 2.02982659292038e-1
n = 500 , left side = 1.67425459808412e-4
1/n^(3/10) = 1.54991898754834e-1

```

difference = 1.54824473295025e-1

$\cos(x)$

n = 10 , left side = 3.74820144167218e-1  
1/n^(3/10) = 5.01187233627272e-1  
difference = 1.26367089460054e-1  
n = 20 , left side = 2.55195709786687e-1  
1/n^(3/10) = 4.07090531536904e-1  
difference = 1.51894821750217e-1  
n = 50 , left side = 1.09512408851853e-1  
1/n^(3/10) = 3.09249494710992e-1  
difference = 1.99737085859139e-1  
n = 100 , left side = 5.52768392704612e-2  
1/n^(3/10) = 2.51188643150958e-1  
difference = 1.95911803880497e-1  
n = 200 , left side = 2.77039874947656e-2  
1/n^(3/10) = 2.04028577336837e-1  
difference = 1.76324589842071e-1  
n = 500 , left side = 1.10889527170912e-2  
1/n^(3/10) = 1.54991898754834e-1  
difference = 1.43902946037742e-1

-----  
x0 = 1/2\*pi, Power = 3/10, lamda = 1/4, q = 1/2  
-----

$\sin(x)$

n = 10 , left side = 2.09589580757104e-1  
1/n^(3/10) = 5.01187233627272e-1  
difference = 2.91597652870168e-1  
n = 20 , left side = 7.13255649254819e-2  
1/n^(3/10) = 4.07090531536904e-1  
difference = 3.35764966611423e-1

```

n = 50 , left side = 1.20373646494268e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.97212130061565e-1
n = 100 , left side = 3.02699828334163e-3
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.48161644867616e-1
n = 200 , left side = 7.57860092323814e-4
          1/n^(3/10) = 2.04028577336837e-1
          difference = 2.03270717244513e-1
n = 500 , left side = 1.21307447419339e-4
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.54870591307414e-1

```

$\cos(x)$

```

n = 10 , left side = 1.87736124441305e-1
          1/n^(3/10) = 5.01187233627272e-1
          difference = 3.13451109185968e-1
n = 20 , left side = 1.28731714979751e-1
          1/n^(3/10) = 4.07090531536904e-1
          difference = 2.78358816557153e-1
n = 50 , left side = 5.48404970391369e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.54408997671855e-1
n = 100 , left side = 2.76490462085282e-2
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.23539596942430e-1
n = 200 , left side = 1.38533249004043e-2
          1/n^(3/10) = 2.04028577336837e-1
          difference = 1.90175252436433e-1
n = 500 , left side = 5.54456160316980e-3
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.49447337151664e-1

```

-----



$x_0 = 1/2\pi$ , Power = 3/10, lamda = 1/4, q = 1

---

$\sin(x)$

```
n = 10 , left side = 2.00900395201895e-1
          1/n^(3/10) = 5.01187233627272e-1
          difference = 3.00286838425377e-1
n = 20 , left side = 6.28049320488506e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.44285599488054e-1
n = 50 , left side = 1.05164762327522e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.98733018478240e-1
n = 100 , left side = 2.64367655879127e-3
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.48544966592167e-1
n = 200 , left side = 6.61834623500557e-4
          1/n^(3/10) = 2.04028577336837e-1
          difference = 2.03366742713336e-1
n = 500 , left side = 1.05934619056391e-4
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.54885964135777e-1
```

$\cos(x)$

```
n = 10 , left side = 1.66610983054087e-2
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.84526135321864e-1
n = 20 , left side = 4.09990480435282e-4
          1/n^(3/10) = 4.07090531536904e-1
          difference = 4.06680541056469e-1
n = 50 , left side = 2.67487880780225e-9
          1/n^(3/10) = 3.09249494710992e-1
          difference = 3.09249492036113e-1
n = 100 , left side = 8.64395924369672e-18
```

```

1/n^(3/10) = 2.51188643150958e-1
difference = 2.51188643150958e-1
n = 200 , left side = 1.45283091113058e-17
1/n^(3/10) = 2.04028577336837e-1
difference = 2.04028577336837e-1
n = 500 , left side = 8.94627014169001e-17
1/n^(3/10) = 1.54991898754834e-1
difference = 1.54991898754834e-1

```

---

```

x0 = 1/2*pi, Power = 3/10, lamda = 1/2, q = 1/4

```

---

$\sin(x)$

```

n = 10 , left side = 9.84826134043599e-2
1/n^(3/10) = 5.01187233627272e-1
difference = 4.02704620222912e-1
n = 20 , left side = 2.61046861206300e-2
1/n^(3/10) = 4.07090531536904e-1
difference = 3.80985845416274e-1
n = 50 , left side = 4.22645955857959e-3
1/n^(3/10) = 3.09249494710992e-1
difference = 3.05023035152412e-1
n = 100 , left side = 1.05840494480958e-3
1/n^(3/10) = 2.51188643150958e-1
difference = 2.50130238206148e-1
n = 200 , left side = 2.64713303538389e-4
1/n^(3/10) = 2.04028577336837e-1
difference = 2.03763864033299e-1
n = 500 , left side = 4.23591513527555e-5
1/n^(3/10) = 1.54991898754834e-1
difference = 1.54949539603481e-1

```

$\cos(x)$

```

n = 10 , left side = 2.54999238457693e-1
          1/n^(3/10) = 5.01187233627272e-1
          difference = 2.46187995169579e-1
n = 20 , left side = 1.35881405538451e-1
          1/n^(3/10) = 4.07090531536904e-1
          difference = 2.71209125998454e-1
n = 50 , left side = 5.52740754515297e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.53975419259462e-1
n = 100 , left side = 2.77036411956434e-2
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.23485001955315e-1
n = 200 , left side = 1.38601618045097e-2
          1/n^(3/10) = 2.04028577336837e-1
          difference = 1.90168415532327e-1
n = 500 , left side = 5.54499938996761e-3
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.49446899364866e-1

```

```

-----
x0 = 1/2*pi, Power = 3/10, lamda = 1/2,  q = 1/2
-----

```

$\sin(x)$

```

n = 10 , left side = 7.25561006486467e-2
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.28631132978626e-1
n = 20 , left side = 1.90326036120037e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.88057927924901e-1
n = 50 , left side = 3.07684651802320e-3
          1/n^(3/10) = 3.09249494710992e-1
          difference = 3.06172648192969e-1
n = 100 , left side = 7.70350593050639e-4

```

```

1/n^(3/10) = 2.51188643150958e-1
difference = 2.50418292557907e-1
n = 200 , left side = 1.92658947488877e-4
1/n^(3/10) = 2.04028577336837e-1
difference = 2.03835918389348e-1
n = 500 , left side = 3.08286271132330e-5
1/n^(3/10) = 1.54991898754834e-1
difference = 1.54961070127720e-1

```

$\cos(x)$

```

n = 10 , left side = 1.28642490007521e-1
1/n^(3/10) = 5.01187233627272e-1
difference = 3.72544743619751e-1
n = 20 , left side = 6.81042176000300e-2
1/n^(3/10) = 4.07090531536904e-1
difference = 3.38986313936874e-1
n = 50 , left side = 2.76476637677382e-2
1/n^(3/10) = 3.09249494710992e-1
difference = 2.81601830943254e-1
n = 100 , left side = 1.38531517342038e-2
1/n^(3/10) = 2.51188643150958e-1
difference = 2.37335491416754e-1
n = 200 , left side = 6.93024738450047e-3
1/n^(3/10) = 2.04028577336837e-1
difference = 1.97098329952337e-1
n = 500 , left side = 2.77251035146457e-3
1/n^(3/10) = 1.54991898754834e-1
difference = 1.52219388403369e-1

```

---

$x_0 = 1/2\pi$ , Power = 3/10, lamda = 1/2, q = 1

---

$\sin(x)$

```

n = 10 , left side = 6.40115086492422e-2
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.37175724978030e-1
n = 20 , left side = 1.66715291654219e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.90419002371483e-1
n = 50 , left side = 2.69354395939936e-3
          1/n^(3/10) = 3.09249494710992e-1
          difference = 3.06555950751592e-1
n = 100 , left side = 6.74326324543562e-4
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.50514316826414e-1
n = 200 , left side = 1.68640444147994e-4
          1/n^(3/10) = 2.04028577336837e-1
          difference = 2.03859936892689e-1
n = 500 , left side = 2.69851091845297e-5
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.54964913645649e-1

```

$$\cos(x)$$

```

n = 10 , left side = 3.68331709595509e-4
          1/n^(3/10) = 5.01187233627272e-1
          difference = 5.00818901917677e-1
n = 20 , left side = 1.81936348575529e-7
          1/n^(3/10) = 4.07090531536904e-1
          difference = 4.07090349600556e-1
n = 50 , left side = 1.15053485964214e-17
          1/n^(3/10) = 3.09249494710992e-1
          difference = 3.09249494710992e-1
n = 100 , left side = 2.66498756652580e-17
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.51188643150958e-1
n = 200 , left side = 2.17356323014423e-17
          1/n^(3/10) = 2.04028577336837e-1
          difference = 2.04028577336837e-1

```

```

n = 500 , left side = 9.06911543942942e-17
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.54991898754834e-1

```

```

-----
x0 = 1/2*pi, Power = 3/10, lamda = 1,  q = 1/4
-----

```

$\sin(x)$

```

n = 10 , left side = 2.73218987411664e-2
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.73865334886106e-1
n = 20 , left side = 6.90589468087832e-3
          1/n^(3/10) = 4.07090531536904e-1
          difference = 4.00184636856026e-1
n = 50 , left side = 1.10835163775835e-3
          1/n^(3/10) = 3.09249494710992e-1
          difference = 3.08141143073233e-1
n = 100 , left side = 2.77209959256730e-4
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.50911433191701e-1
n = 200 , left side = 6.93101217305037e-5
          1/n^(3/10) = 2.04028577336837e-1
          difference = 2.03959267215106e-1
n = 500 , left side = 1.10899618150917e-5
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.54980808793019e-1

```

$\cos(x)$

```

n = 10 , left side = 1.35711685154782e-1
          1/n^(3/10) = 5.01187233627272e-1
          difference = 3.65475548472490e-1
n = 20 , left side = 6.89464901817200e-2

```

```

1/n^(3/10) = 4.07090531536904e-1
difference = 3.38144041355184e-1
n = 50 , left side = 2.77022557225577e-2
1/n^(3/10) = 3.09249494710992e-1
difference = 2.81547238988434e-1
n = 100 , left side = 1.38599886244430e-2
1/n^(3/10) = 2.51188643150958e-1
difference = 2.37328654526515e-1
n = 200 , left side = 6.93110233963074e-3
1/n^(3/10) = 2.04028577336837e-1
difference = 1.97097474997206e-1
n = 500 , left side = 2.77256501313648e-3
1/n^(3/10) = 1.54991898754834e-1
difference = 1.52219333741697e-1

```

-----  
x0 = 1/2\*pi, Power = 3/10, lamda = 1, q = 1/2  
-----

```

sin(x)
n = 10 , left side = 2.02586050377557e-2
1/n^(3/10) = 5.01187233627272e-1
difference = 4.80928628589517e-1
n = 20 , left side = 5.11322907698708e-3
1/n^(3/10) = 4.07090531536904e-1
difference = 4.01977302459917e-1
n = 50 , left side = 8.20311672977803e-4
1/n^(3/10) = 3.09249494710992e-1
difference = 3.08429183038014e-1
n = 100 , left side = 2.05156512414262e-4
1/n^(3/10) = 2.51188643150958e-1
difference = 2.50983486638544e-1
n = 200 , left side = 5.12940438195386e-5
1/n^(3/10) = 2.04028577336837e-1

```

```

        difference = 2.03977283293017e-1
n = 500 , left side = 8.20726742567501e-6
        1/n^(3/10) = 1.54991898754834e-1
        difference = 1.54983691487408e-1

```

$\cos(x)$

```

n = 10 , left side = 6.80191579414196e-2
        1/n^(3/10) = 5.01187233627272e-1
        difference = 4.33168075685853e-1
n = 20 , left side = 3.44939608010511e-2
        1/n^(3/10) = 4.07090531536904e-1
        difference = 3.72596570735853e-1
n = 50 , left side = 1.38524597520624e-2
        1/n^(3/10) = 3.09249494710992e-1
        difference = 2.95397034958929e-1
n = 100 , left side = 6.93016042367867e-3
        1/n^(3/10) = 2.51188643150958e-1
        difference = 2.44258482727279e-1
n = 200 , left side = 3.46557187207865e-3
        1/n^(3/10) = 2.04028577336837e-1
        difference = 2.00563005464758e-1
n = 500 , left side = 1.38628390798492e-3
        1/n^(3/10) = 1.54991898754834e-1
        difference = 1.53605614846849e-1

```

---

```

x0 = 1/2*pi, Power = 3/10, lamda = 1,  q = 1

```

---

$\sin(x)$

```

n = 10 , left side = 1.79004576579427e-2
        1/n^(3/10) = 5.01187233627272e-1
        difference = 4.83286775969330e-1

```



$n = 20$  , left side =  $4.51543399532339e-3$   
 $1/n^{(3/10)} = 4.07090531536904e-1$   
difference =  $4.02575097541581e-1$   
 $n = 50$  , left side =  $7.24292150886985e-4$   
 $1/n^{(3/10)} = 3.09249494710992e-1$   
difference =  $3.08525202560105e-1$   
 $n = 100$  , left side =  $1.81138319373719e-4$   
 $1/n^{(3/10)} = 2.51188643150958e-1$   
difference =  $2.51007504831584e-1$   
 $n = 200$  , left side =  $4.52886594521917e-5$   
 $1/n^{(3/10)} = 2.04028577336837e-1$   
difference =  $2.03983288677385e-1$   
 $n = 500$  , left side =  $7.24636777071908e-6$   
 $1/n^{(3/10)} = 1.54991898754834e-1$   
difference =  $1.54984652387063e-1$

$\cos(x)$

$n = 10$  , left side =  $1.57869523854596e-7$   
 $1/n^{(3/10)} = 5.01187233627272e-1$   
difference =  $5.01187075757748e-1$   
 $n = 20$  , left side =  $8.57307835911959e-10$   
 $1/n^{(3/10)} = 4.07090531536904e-1$   
difference =  $4.07090530679597e-1$   
 $n = 50$  , left side =  $1.66778327101737e-10$   
 $1/n^{(3/10)} = 3.09249494710992e-1$   
difference =  $3.09249494544213e-1$   
 $n = 100$  , left side =  $1.61355729577713e-10$   
 $1/n^{(3/10)} = 2.51188643150958e-1$   
difference =  $2.51188642989602e-1$   
 $n = 200$  , left side =  $1.41525502993151e-10$   
 $1/n^{(3/10)} = 2.04028577336837e-1$   
difference =  $2.04028577195311e-1$   
 $n = 500$  , left side =  $4.01468513110386e-11$   
 $1/n^{(3/10)} = 1.54991898754834e-1$   
difference =  $1.54991898714687e-1$

-----  
 $x_0 = 1/2\pi$ , Power = 1/2, lamda = 1/4, q = 1/4  
 -----

$\sin(x)$

n = 10 , left side = 2.59670416080878e-1  
           1/n<sup>(1/2)</sup> = 3.16227766016838e-1  
           difference = 5.65573499359598e-2  
 n = 20 , left side = 9.72188312719504e-2  
           1/n<sup>(1/2)</sup> = 2.23606797749979e-1  
           difference = 1.26387966478029e-1  
 n = 50 , left side = 1.65953574461681e-2  
           1/n<sup>(1/2)</sup> = 1.41421356237310e-1  
           difference = 1.24825998791141e-1  
 n = 100 , left side = 4.17666880694489e-3  
           1/n<sup>(1/2)</sup> = 1.00000000000000e-1  
           difference = 9.58233311930551e-2  
 n = 200 , left side = 1.04591804479937e-3  
           1/n<sup>(1/2)</sup> = 7.07106781186548e-2  
           difference = 6.96647600738554e-2  
 n = 500 , left side = 1.67425459808412e-4  
           1/n<sup>(1/2)</sup> = 4.47213595499958e-2  
           difference = 4.45539340901874e-2

$\cos(x)$

n = 10 , left side = 3.74820144167218e-1  
           1/n<sup>(1/2)</sup> = 3.16227766016838e-1  
           difference = -5.85923781503805e-2  
 n = 20 , left side = 2.55195709786687e-1  
           1/n<sup>(1/2)</sup> = 2.23606797749979e-1  
           difference = -3.15889120367084e-2  
 n = 50 , left side = 1.09512408851853e-1

```

1/n^(1/2) = 1.41421356237310e-1
difference = 3.19089473854569e-2
n = 100 , left side = 5.52768392704612e-2
1/n^(1/2) = 1.00000000000000e-1
difference = 4.47231607295388e-2
n = 200 , left side = 2.77039874947656e-2
1/n^(1/2) = 7.07106781186548e-2
difference = 4.30066906238892e-2
n = 500 , left side = 1.10889527170912e-2
1/n^(1/2) = 4.47213595499958e-2
difference = 3.36324068329046e-2

```

-----  
 $x_0 = 1/2\pi$ , Power = 1/2, lamda = 1/4, q = 1/2  
 -----

$\sin(x)$

```

n = 10 , left side = 2.09589580757104e-1
1/n^(1/2) = 3.16227766016838e-1
difference = 1.06638185259734e-1
n = 20 , left side = 7.13255649254819e-2
1/n^(1/2) = 2.23606797749979e-1
difference = 1.52281232824497e-1
n = 50 , left side = 1.20373646494268e-2
1/n^(1/2) = 1.41421356237310e-1
difference = 1.29383991587883e-1
n = 100 , left side = 3.02699828334163e-3
1/n^(1/2) = 1.00000000000000e-1
difference = 9.69730017166584e-2
n = 200 , left side = 7.57860092323814e-4
1/n^(1/2) = 7.07106781186548e-2
difference = 6.99528180263309e-2
n = 500 , left side = 1.21307447419339e-4
1/n^(1/2) = 4.47213595499958e-2

```

difference = 4.46000521025765e-2

$\cos(x)$

n = 10 , left side = 1.87736124441305e-1  
1/n^(1/2) = 3.16227766016838e-1  
difference = 1.28491641575533e-1  
n = 20 , left side = 1.28731714979751e-1  
1/n^(1/2) = 2.23606797749979e-1  
difference = 9.48750827702277e-2  
n = 50 , left side = 5.48404970391369e-2  
1/n^(1/2) = 1.41421356237310e-1  
difference = 8.65808591981726e-2  
n = 100 , left side = 2.76490462085282e-2  
1/n^(1/2) = 1.00000000000000e-1  
difference = 7.23509537914718e-2  
n = 200 , left side = 1.38533249004043e-2  
1/n^(1/2) = 7.07106781186548e-2  
difference = 5.68573532182505e-2  
n = 500 , left side = 5.54456160316980e-3  
1/n^(1/2) = 4.47213595499958e-2  
difference = 3.91767979468260e-2

-----  
x0 = 1/2\*pi, Power = 1/2, lamda = 1/4, q = 1  
-----

$\sin(x)$

n = 10 , left side = 2.00900395201895e-1  
1/n^(1/2) = 3.16227766016838e-1  
difference = 1.15327370814943e-1  
n = 20 , left side = 6.28049320488506e-2  
1/n^(1/2) = 2.23606797749979e-1  
difference = 1.60801865701128e-1

```

n = 50 , left side = 1.05164762327522e-2
          1/n^(1/2) = 1.41421356237310e-1
          difference = 1.30904880004557e-1
n = 100 , left side = 2.64367655879127e-3
          1/n^(1/2) = 1.00000000000000e-1
          difference = 9.73563234412087e-2
n = 200 , left side = 6.61834623500557e-4
          1/n^(1/2) = 7.07106781186548e-2
          difference = 7.00488434951542e-2
n = 500 , left side = 1.05934619056391e-4
          1/n^(1/2) = 4.47213595499958e-2
          difference = 4.46154249309394e-2

```

$\cos(x)$

```

n = 10 , left side = 1.66610983054087e-2
          1/n^(1/2) = 3.16227766016838e-1
          difference = 2.99566667711429e-1
n = 20 , left side = 4.09990480435282e-4
          1/n^(1/2) = 2.23606797749979e-1
          difference = 2.23196807269544e-1
n = 50 , left side = 2.67487880780225e-9
          1/n^(1/2) = 1.41421356237310e-1
          difference = 1.41421353562431e-1
n = 100 , left side = 8.64395924369672e-18
          1/n^(1/2) = 1.00000000000000e-1
          difference = 1.00000000000000e-1
n = 200 , left side = 1.45283091113058e-17
          1/n^(1/2) = 7.07106781186548e-2
          difference = 7.07106781186547e-2
n = 500 , left side = 8.94627014169001e-17
          1/n^(1/2) = 4.47213595499958e-2
          difference = 4.47213595499957e-2

```

-----

$x_0 = 1/2\pi$ , Power = 1/2, lamda = 1/2, q = 1/4

---

$\sin(x)$

n = 10 , left side = 9.84826134043599e-2  
1/n^(1/2) = 3.16227766016838e-1  
difference = 2.17745152612478e-1  
n = 20 , left side = 2.61046861206300e-2  
1/n^(1/2) = 2.23606797749979e-1  
difference = 1.97502111629349e-1  
n = 50 , left side = 4.22645955857959e-3  
1/n^(1/2) = 1.41421356237310e-1  
difference = 1.37194896678730e-1  
n = 100 , left side = 1.05840494480958e-3  
1/n^(1/2) = 1.00000000000000e-1  
difference = 9.89415950551904e-2  
n = 200 , left side = 2.64713303538389e-4  
1/n^(1/2) = 7.07106781186548e-2  
difference = 7.04459648151164e-2  
n = 500 , left side = 4.23591513527555e-5  
1/n^(1/2) = 4.47213595499958e-2  
difference = 4.46790003986430e-2

$\cos(x)$

n = 10 , left side = 2.54999238457693e-1  
1/n^(1/2) = 3.16227766016838e-1  
difference = 6.12285275591446e-2  
n = 20 , left side = 1.35881405538451e-1  
1/n^(1/2) = 2.23606797749979e-1  
difference = 8.77253922115282e-2  
n = 50 , left side = 5.52740754515297e-2  
1/n^(1/2) = 1.41421356237310e-1  
difference = 8.61472807857798e-2  
n = 100 , left side = 2.77036411956434e-2

```

1/n^(1/2) = 1.000000000000000e-1
difference = 7.22963588043566e-2
n = 200 , left side = 1.38601618045097e-2
1/n^(1/2) = 7.07106781186548e-2
difference = 5.68505163141450e-2
n = 500 , left side = 5.54499938996761e-3
1/n^(1/2) = 4.47213595499958e-2
difference = 3.91763601600282e-2

```

-----  
 $x_0 = 1/2\pi$ , Power = 1/2, lamda = 1/2, q = 1/2  
 -----

```

sin(x)
n = 10 , left side = 7.25561006486467e-2
1/n^(1/2) = 3.16227766016838e-1
difference = 2.43671665368191e-1
n = 20 , left side = 1.90326036120037e-2
1/n^(1/2) = 2.23606797749979e-1
difference = 2.04574194137975e-1
n = 50 , left side = 3.07684651802320e-3
1/n^(1/2) = 1.41421356237310e-1
difference = 1.38344509719286e-1
n = 100 , left side = 7.70350593050639e-4
1/n^(1/2) = 1.000000000000000e-1
difference = 9.92296494069494e-2
n = 200 , left side = 1.92658947488877e-4
1/n^(1/2) = 7.07106781186548e-2
difference = 7.05180191711659e-2
n = 500 , left side = 3.08286271132330e-5
1/n^(1/2) = 4.47213595499958e-2
difference = 4.46905309228826e-2

```

```

cos(x)

```

```

n = 10 , left side = 1.28642490007521e-1
          1/n^(1/2) = 3.16227766016838e-1
          difference = 1.87585276009317e-1
n = 20 , left side = 6.81042176000300e-2
          1/n^(1/2) = 2.23606797749979e-1
          difference = 1.55502580149949e-1
n = 50 , left side = 2.76476637677382e-2
          1/n^(1/2) = 1.41421356237310e-1
          difference = 1.13773692469571e-1
n = 100 , left side = 1.38531517342038e-2
          1/n^(1/2) = 1.00000000000000e-1
          difference = 8.61468482657962e-2
n = 200 , left side = 6.93024738450047e-3
          1/n^(1/2) = 7.07106781186548e-2
          difference = 6.37804307341543e-2
n = 500 , left side = 2.77251035146457e-3
          1/n^(1/2) = 4.47213595499958e-2
          difference = 4.19488491985312e-2

```

```

-----
x0 = 1/2*pi, Power = 1/2, lamda = 1/2,  q = 1
-----

```

$\sin(x)$

```

n = 10 , left side = 6.40115086492422e-2
          1/n^(1/2) = 3.16227766016838e-1
          difference = 2.52216257367596e-1
n = 20 , left side = 1.66715291654219e-2
          1/n^(1/2) = 2.23606797749979e-1
          difference = 2.06935268584557e-1
n = 50 , left side = 2.69354395939936e-3
          1/n^(1/2) = 1.41421356237310e-1
          difference = 1.38727812277910e-1
n = 100 , left side = 6.74326324543562e-4

```



```

1/n^(1/2) = 1.000000000000000e-1
difference = 9.93256736754564e-2
n = 200 , left side = 1.68640444147994e-4
1/n^(1/2) = 7.07106781186548e-2
difference = 7.05420376745068e-2
n = 500 , left side = 2.69851091845297e-5
1/n^(1/2) = 4.47213595499958e-2
difference = 4.46943744408113e-2

```

$\cos(x)$

```

n = 10 , left side = 3.68331709595509e-4
1/n^(1/2) = 3.16227766016838e-1
difference = 3.15859434307242e-1
n = 20 , left side = 1.81936348575529e-7
1/n^(1/2) = 2.23606797749979e-1
difference = 2.23606615813630e-1
n = 50 , left side = 1.15053485964214e-17
1/n^(1/2) = 1.41421356237310e-1
difference = 1.41421356237310e-1
n = 100 , left side = 2.66498756652580e-17
1/n^(1/2) = 1.00000000000000e-1
difference = 1.00000000000000e-1
n = 200 , left side = 2.17356323014423e-17
1/n^(1/2) = 7.07106781186548e-2
difference = 7.07106781186547e-2
n = 500 , left side = 9.06911543942942e-17
1/n^(1/2) = 4.47213595499958e-2
difference = 4.47213595499957e-2

```

---

$x_0 = 1/2\pi$ , Power = 1/2, lamda = 1, q = 1/4

---

$\sin(x)$

$n = 10$  , left side = 2.73218987411664e-2  
 $1/n^{(1/2)} = 3.16227766016838e-1$   
difference = 2.88905867275672e-1  
 $n = 20$  , left side = 6.90589468087832e-3  
 $1/n^{(1/2)} = 2.23606797749979e-1$   
difference = 2.16700903069101e-1  
 $n = 50$  , left side = 1.10835163775835e-3  
 $1/n^{(1/2)} = 1.41421356237310e-1$   
difference = 1.40313004599551e-1  
 $n = 100$  , left side = 2.77209959256730e-4  
 $1/n^{(1/2)} = 1.00000000000000e-1$   
difference = 9.97227900407433e-2  
 $n = 200$  , left side = 6.93101217305037e-5  
 $1/n^{(1/2)} = 7.07106781186548e-2$   
difference = 7.06413679969242e-2  
 $n = 500$  , left side = 1.10899618150917e-5  
 $1/n^{(1/2)} = 4.47213595499958e-2$   
difference = 4.47102695881807e-2

$$\cos(x)$$

$n = 10$  , left side = 1.35711685154782e-1  
 $1/n^{(1/2)} = 3.16227766016838e-1$   
difference = 1.80516080862056e-1  
 $n = 20$  , left side = 6.89464901817200e-2  
 $1/n^{(1/2)} = 2.23606797749979e-1$   
difference = 1.54660307568259e-1  
 $n = 50$  , left side = 2.77022557225577e-2  
 $1/n^{(1/2)} = 1.41421356237310e-1$   
difference = 1.13719100514752e-1  
 $n = 100$  , left side = 1.38599886244430e-2  
 $1/n^{(1/2)} = 1.00000000000000e-1$   
difference = 8.61400113755570e-2  
 $n = 200$  , left side = 6.93110233963074e-3  
 $1/n^{(1/2)} = 7.07106781186548e-2$   
difference = 6.37795757790240e-2

```

n = 500 , left side = 2.77256501313648e-3
          1/n^(1/2) = 4.47213595499958e-2
          difference = 4.19487945368593e-2

```

```

-----
x0 = 1/2*pi, Power = 1/2, lamda = 1,  q = 1/2
-----

```

$\sin(x)$

```

n = 10 , left side = 2.02586050377557e-2
          1/n^(1/2) = 3.16227766016838e-1
          difference = 2.95969160979082e-1
n = 20 , left side = 5.11322907698708e-3
          1/n^(1/2) = 2.23606797749979e-1
          difference = 2.18493568672992e-1
n = 50 , left side = 8.20311672977803e-4
          1/n^(1/2) = 1.41421356237310e-1
          difference = 1.40601044564332e-1
n = 100 , left side = 2.05156512414262e-4
          1/n^(1/2) = 1.00000000000000e-1
          difference = 9.97948434875857e-2
n = 200 , left side = 5.12940438195386e-5
          1/n^(1/2) = 7.07106781186548e-2
          difference = 7.06593840748352e-2
n = 500 , left side = 8.20726742567501e-6
          1/n^(1/2) = 4.47213595499958e-2
          difference = 4.47131522825701e-2

```

$\cos(x)$

```

n = 10 , left side = 6.80191579414196e-2
          1/n^(1/2) = 3.16227766016838e-1
          difference = 2.48208608075418e-1
n = 20 , left side = 3.44939608010511e-2

```

```

1/n^(1/2) = 2.23606797749979e-1
difference = 1.89112836948928e-1
n = 50 , left side = 1.38524597520624e-2
1/n^(1/2) = 1.41421356237310e-1
difference = 1.27568896485247e-1
n = 100 , left side = 6.93016042367867e-3
1/n^(1/2) = 1.00000000000000e-1
difference = 9.30698395763213e-2
n = 200 , left side = 3.46557187207865e-3
1/n^(1/2) = 7.07106781186548e-2
difference = 6.72451062465761e-2
n = 500 , left side = 1.38628390798492e-3
1/n^(1/2) = 4.47213595499958e-2
difference = 4.33350756420109e-2

```

-----  
 $x_0 = 1/2\pi$ , Power = 1/2, lamda = 1, q = 1  
 -----

$\sin(x)$

```

n = 10 , left side = 1.79004576579427e-2
1/n^(1/2) = 3.16227766016838e-1
difference = 2.98327308358895e-1
n = 20 , left side = 4.51543399532339e-3
1/n^(1/2) = 2.23606797749979e-1
difference = 2.19091363754656e-1
n = 50 , left side = 7.24292150886985e-4
1/n^(1/2) = 1.41421356237310e-1
difference = 1.40697064086423e-1
n = 100 , left side = 1.81138319373719e-4
1/n^(1/2) = 1.00000000000000e-1
difference = 9.98188616806263e-2
n = 200 , left side = 4.52886594521917e-5
1/n^(1/2) = 7.07106781186548e-2

```

```

difference = 7.06653894592026e-2
n = 500 , left side = 7.24636777071908e-6
1/n^(1/2) = 4.47213595499958e-2
difference = 4.47141131822251e-2

```

$\cos(x)$

```

n = 10 , left side = 1.57869523854596e-7
1/n^(1/2) = 3.16227766016838e-1
difference = 3.16227608147314e-1
n = 20 , left side = 8.57307835911959e-10
1/n^(1/2) = 2.23606797749979e-1
difference = 2.23606796892671e-1
n = 50 , left side = 1.66778327101737e-10
1/n^(1/2) = 1.41421356237310e-1
difference = 1.41421356070531e-1
n = 100 , left side = 1.61355729577713e-10
1/n^(1/2) = 1.00000000000000e-1
difference = 9.99999998386443e-2
n = 200 , left side = 1.41525502993151e-10
1/n^(1/2) = 7.07106781186548e-2
difference = 7.07106779771293e-2
n = 500 , left side = 4.01468513110386e-11
1/n^(1/2) = 4.47213595499958e-2
difference = 4.47213595098489e-2

```

---

$x_0 = 1/2\pi$ , Power = 7/10, lamda = 1/4, q = 1/4

---

$\sin(x)$

```

n = 10 , left side = 2.59670416080878e-1
1/n^(7/10) = 1.99526231496888e-1
difference = -6.01441845839902e-2

```

```

n = 20 , left side = 9.72188312719504e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 2.56039713396286e-2
n = 50 , left side = 1.65953574461681e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = 4.80773432115676e-2
n = 100 , left side = 4.17666880694489e-3
          1/n^(7/10) = 3.98107170553497e-2
          difference = 3.56340482484048e-2
n = 200 , left side = 1.04591804479937e-3
          1/n^(7/10) = 2.45063709469745e-2
          difference = 2.34604529021751e-2
n = 500 , left side = 1.67425459808412e-4
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.27364747831559e-2

```

$\cos(x)$

```

n = 10 , left side = 3.74820144167218e-1
          1/n^(7/10) = 1.99526231496888e-1
          difference = -1.75293912670330e-1
n = 20 , left side = 2.55195709786687e-1
          1/n^(7/10) = 1.22822802611579e-1
          difference = -1.32372907175108e-1
n = 50 , left side = 1.09512408851853e-1
          1/n^(7/10) = 6.46727006577358e-2
          difference = -4.48397081941169e-2
n = 100 , left side = 5.52768392704612e-2
          1/n^(7/10) = 3.98107170553497e-2
          difference = -1.54661222151115e-2
n = 200 , left side = 2.77039874947656e-2
          1/n^(7/10) = 2.45063709469745e-2
          difference = -3.19761654779109e-3
n = 500 , left side = 1.10889527170912e-2
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.81494752587308e-3

```

-----  
 $x_0 = 1/2\pi$ , Power = 7/10, lamda = 1/4, q = 1/2  
 -----

$\sin(x)$

```

n = 10 , left side = 2.09589580757104e-1
          1/n^(7/10) = 1.99526231496888e-1
          difference = -1.00633492602161e-2
n = 20 , left side = 7.13255649254819e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 5.14972376860971e-2
n = 50 , left side = 1.20373646494268e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = 5.26353360083089e-2
n = 100 , left side = 3.02699828334163e-3
          1/n^(7/10) = 3.98107170553497e-2
          difference = 3.67837187720081e-2
n = 200 , left side = 7.57860092323814e-4
          1/n^(7/10) = 2.45063709469745e-2
          difference = 2.37485108546507e-2
n = 500 , left side = 1.21307447419339e-4
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.27825927955450e-2

```

$\cos(x)$

```

n = 10 , left side = 1.87736124441305e-1
          1/n^(7/10) = 1.99526231496888e-1
          difference = 1.17901070555831e-2
n = 20 , left side = 1.28731714979751e-1
          1/n^(7/10) = 1.22822802611579e-1
          difference = -5.90891236817218e-3
n = 50 , left side = 5.48404970391369e-2

```

```

1/n^(7/10) = 6.46727006577358e-2
difference = 9.83220361859886e-3
n = 100 , left side = 2.76490462085282e-2
1/n^(7/10) = 3.98107170553497e-2
difference = 1.21616708468215e-2
n = 200 , left side = 1.38533249004043e-2
1/n^(7/10) = 2.45063709469745e-2
difference = 1.06530460465702e-2
n = 500 , left side = 5.54456160316980e-3
1/n^(7/10) = 1.29039002429643e-2
difference = 7.35933863979452e-3

```

-----  
 $x_0 = 1/2\pi$ , Power = 7/10, lamda = 1/4, q = 1  
 -----

```

sin(x)
n = 10 , left side = 2.00900395201895e-1
1/n^(7/10) = 1.99526231496888e-1
difference = -1.37416370500729e-3
n = 20 , left side = 6.28049320488506e-2
1/n^(7/10) = 1.22822802611579e-1
difference = 6.00178705627284e-2
n = 50 , left side = 1.05164762327522e-2
1/n^(7/10) = 6.46727006577358e-2
difference = 5.41562244249836e-2
n = 100 , left side = 2.64367655879127e-3
1/n^(7/10) = 3.98107170553497e-2
difference = 3.71670404965585e-2
n = 200 , left side = 6.61834623500557e-4
1/n^(7/10) = 2.45063709469745e-2
difference = 2.38445363234739e-2
n = 500 , left side = 1.05934619056391e-4
1/n^(7/10) = 1.29039002429643e-2

```



difference = 1.27979656239079e-2

$\cos(x)$

n = 10 , left side = 1.66610983054087e-2  
1/n^(7/10) = 1.99526231496888e-1  
difference = 1.82865133191479e-1  
n = 20 , left side = 4.09990480435282e-4  
1/n^(7/10) = 1.22822802611579e-1  
difference = 1.22412812131144e-1  
n = 50 , left side = 2.67487880780225e-9  
1/n^(7/10) = 6.46727006577358e-2  
difference = 6.46726979828569e-2  
n = 100 , left side = 8.64395924369672e-18  
1/n^(7/10) = 3.98107170553497e-2  
difference = 3.98107170553497e-2  
n = 200 , left side = 1.45283091113058e-17  
1/n^(7/10) = 2.45063709469745e-2  
difference = 2.45063709469745e-2  
n = 500 , left side = 8.94627014169001e-17  
1/n^(7/10) = 1.29039002429643e-2  
difference = 1.29039002429642e-2

-----  
x0 = 1/2\*pi, Power = 7/10, lamda = 1/2, q = 1/4  
-----

$\sin(x)$

n = 10 , left side = 9.84826134043599e-2  
1/n^(7/10) = 1.99526231496888e-1  
difference = 1.01043618092528e-1  
n = 20 , left side = 2.61046861206300e-2  
1/n^(7/10) = 1.22822802611579e-1  
difference = 9.67181164909491e-2

```

n = 50 , left side = 4.22645955857959e-3
          1/n^(7/10) = 6.46727006577358e-2
          difference = 6.04462410991562e-2
n = 100 , left side = 1.05840494480958e-3
          1/n^(7/10) = 3.98107170553497e-2
          difference = 3.87523121105402e-2
n = 200 , left side = 2.64713303538389e-4
          1/n^(7/10) = 2.45063709469745e-2
          difference = 2.42416576434361e-2
n = 500 , left side = 4.23591513527555e-5
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.28615410916116e-2

```

$\cos(x)$

```

n = 10 , left side = 2.54999238457693e-1
          1/n^(7/10) = 1.99526231496888e-1
          difference = -5.54730069608053e-2
n = 20 , left side = 1.35881405538451e-1
          1/n^(7/10) = 1.22822802611579e-1
          difference = -1.30586029268717e-2
n = 50 , left side = 5.52740754515297e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = 9.39862520620604e-3
n = 100 , left side = 2.77036411956434e-2
          1/n^(7/10) = 3.98107170553497e-2
          difference = 1.21070758597063e-2
n = 200 , left side = 1.38601618045097e-2
          1/n^(7/10) = 2.45063709469745e-2
          difference = 1.06462091424648e-2
n = 500 , left side = 5.54499938996761e-3
          1/n^(7/10) = 1.29039002429643e-2
          difference = 7.35890085299672e-3

```

-----

$x_0 = 1/2\pi$ , Power = 7/10, lamda = 1/2, q = 1/2

---

$\sin(x)$

```
n = 10 , left side = 7.25561006486467e-2
          1/n^(7/10) = 1.99526231496888e-1
          difference = 1.26970130848241e-1
n = 20 , left side = 1.90326036120037e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 1.03790198999575e-1
n = 50 , left side = 3.07684651802320e-3
          1/n^(7/10) = 6.46727006577358e-2
          difference = 6.15958541397126e-2
n = 100 , left side = 7.70350593050639e-4
          1/n^(7/10) = 3.98107170553497e-2
          difference = 3.90403664622991e-2
n = 200 , left side = 1.92658947488877e-4
          1/n^(7/10) = 2.45063709469745e-2
          difference = 2.43137119994856e-2
n = 500 , left side = 3.08286271132330e-5
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.28730716158511e-2
```

$\cos(x)$

```
n = 10 , left side = 1.28642490007521e-1
          1/n^(7/10) = 1.99526231496888e-1
          difference = 7.08837414893666e-2
n = 20 , left side = 6.81042176000300e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 5.47185850115491e-2
n = 50 , left side = 2.76476637677382e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = 3.70250368899976e-2
n = 100 , left side = 1.38531517342038e-2
```

```

1/n^(7/10) = 3.98107170553497e-2
difference = 2.59575653211459e-2
n = 200 , left side = 6.93024738450047e-3
1/n^(7/10) = 2.45063709469745e-2
difference = 1.75761235624740e-2
n = 500 , left side = 2.77251035146457e-3
1/n^(7/10) = 1.29039002429643e-2
difference = 1.01313898914998e-2

```

-----  
x0 = 1/2\*pi, Power = 7/10, lamda = 1/2, q = 1  
-----

$\sin(x)$

```

n = 10 , left side = 6.40115086492422e-2
1/n^(7/10) = 1.99526231496888e-1
difference = 1.35514722847646e-1
n = 20 , left side = 1.66715291654219e-2
1/n^(7/10) = 1.22822802611579e-1
difference = 1.06151273446157e-1
n = 50 , left side = 2.69354395939936e-3
1/n^(7/10) = 6.46727006577358e-2
difference = 6.19791566983364e-2
n = 100 , left side = 6.74326324543562e-4
1/n^(7/10) = 3.98107170553497e-2
difference = 3.91363907308062e-2
n = 200 , left side = 1.68640444147994e-4
1/n^(7/10) = 2.45063709469745e-2
difference = 2.43377305028265e-2
n = 500 , left side = 2.69851091845297e-5
1/n^(7/10) = 1.29039002429643e-2
difference = 1.28769151337798e-2

```

$\cos(x)$

```

n = 10 , left side = 3.68331709595509e-4
          1/n^(7/10) = 1.99526231496888e-1
          difference = 1.99157899787292e-1
n = 20 , left side = 1.81936348575529e-7
          1/n^(7/10) = 1.22822802611579e-1
          difference = 1.22822620675230e-1
n = 50 , left side = 1.15053485964214e-17
          1/n^(7/10) = 6.46727006577358e-2
          difference = 6.46727006577357e-2
n = 100 , left side = 2.66498756652580e-17
          1/n^(7/10) = 3.98107170553497e-2
          difference = 3.98107170553497e-2
n = 200 , left side = 2.17356323014423e-17
          1/n^(7/10) = 2.45063709469745e-2
          difference = 2.45063709469745e-2
n = 500 , left side = 9.06911543942942e-17
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.29039002429642e-2

```

-----  
 $x_0 = 1/2\pi$ , Power = 7/10, lamda = 1, q = 1/4  
 -----

$\sin(x)$

```

n = 10 , left side = 2.73218987411664e-2
          1/n^(7/10) = 1.99526231496888e-1
          difference = 1.72204332755722e-1
n = 20 , left side = 6.90589468087832e-3
          1/n^(7/10) = 1.22822802611579e-1
          difference = 1.15916907930701e-1
n = 50 , left side = 1.10835163775835e-3
          1/n^(7/10) = 6.46727006577358e-2
          difference = 6.35643490199774e-2
n = 100 , left side = 2.77209959256730e-4

```

```

1/n^(7/10) = 3.98107170553497e-2
difference = 3.95335070960930e-2
n = 200 , left side = 6.93101217305037e-5
1/n^(7/10) = 2.45063709469745e-2
difference = 2.44370608252440e-2
n = 500 , left side = 1.10899618150917e-5
1/n^(7/10) = 1.29039002429643e-2
difference = 1.28928102811492e-2

```

$\cos(x)$

```

n = 10 , left side = 1.35711685154782e-1
1/n^(7/10) = 1.99526231496888e-1
difference = 6.38145463421060e-2
n = 20 , left side = 6.89464901817200e-2
1/n^(7/10) = 1.22822802611579e-1
difference = 5.38763124298591e-2
n = 50 , left side = 2.77022557225577e-2
1/n^(7/10) = 6.46727006577358e-2
difference = 3.69704449351780e-2
n = 100 , left side = 1.38599886244430e-2
1/n^(7/10) = 3.98107170553497e-2
difference = 2.59507284309068e-2
n = 200 , left side = 6.93110233963074e-3
1/n^(7/10) = 2.45063709469745e-2
difference = 1.75752686073438e-2
n = 500 , left side = 2.77256501313648e-3
1/n^(7/10) = 1.29039002429643e-2
difference = 1.01313352298278e-2

```

---

$x_0 = 1/2\pi$ , Power = 7/10, lamda = 1, q = 1/2

---

$\sin(x)$

$n = 10$  , left side =  $2.02586050377557e-2$   
 $1/n^{(7/10)} = 1.99526231496888e-1$   
difference =  $1.79267626459132e-1$   
 $n = 20$  , left side =  $5.11322907698708e-3$   
 $1/n^{(7/10)} = 1.22822802611579e-1$   
difference =  $1.17709573534592e-1$   
 $n = 50$  , left side =  $8.20311672977803e-4$   
 $1/n^{(7/10)} = 6.46727006577358e-2$   
difference =  $6.38523889847580e-2$   
 $n = 100$  , left side =  $2.05156512414262e-4$   
 $1/n^{(7/10)} = 3.98107170553497e-2$   
difference =  $3.96055605429355e-2$   
 $n = 200$  , left side =  $5.12940438195386e-5$   
 $1/n^{(7/10)} = 2.45063709469745e-2$   
difference =  $2.44550769031550e-2$   
 $n = 500$  , left side =  $8.20726742567501e-6$   
 $1/n^{(7/10)} = 1.29039002429643e-2$   
difference =  $1.28956929755386e-2$

$\cos(x)$

$n = 10$  , left side =  $6.80191579414196e-2$   
 $1/n^{(7/10)} = 1.99526231496888e-1$   
difference =  $1.31507073555468e-1$   
 $n = 20$  , left side =  $3.44939608010511e-2$   
 $1/n^{(7/10)} = 1.22822802611579e-1$   
difference =  $8.83288418105280e-2$   
 $n = 50$  , left side =  $1.38524597520624e-2$   
 $1/n^{(7/10)} = 6.46727006577358e-2$   
difference =  $5.08202409056733e-2$   
 $n = 100$  , left side =  $6.93016042367867e-3$   
 $1/n^{(7/10)} = 3.98107170553497e-2$   
difference =  $3.28805566316711e-2$   
 $n = 200$  , left side =  $3.46557187207865e-3$   
 $1/n^{(7/10)} = 2.45063709469745e-2$   
difference =  $2.10407990748959e-2$

```

n = 500 , left side = 1.38628390798492e-3
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.15176163349794e-2

```

```

-----
x0 = 1/2*pi, Power = 7/10, lamda = 1,  q = 1
-----

```

$\sin(x)$

```

n = 10 , left side = 1.79004576579427e-2
          1/n^(7/10) = 1.99526231496888e-1
          difference = 1.81625773838945e-1
n = 20 , left side = 4.51543399532339e-3
          1/n^(7/10) = 1.22822802611579e-1
          difference = 1.18307368616256e-1
n = 50 , left side = 7.24292150886985e-4
          1/n^(7/10) = 6.46727006577358e-2
          difference = 6.39484085068488e-2
n = 100 , left side = 1.81138319373719e-4
          1/n^(7/10) = 3.98107170553497e-2
          difference = 3.96295787359760e-2
n = 200 , left side = 4.52886594521917e-5
          1/n^(7/10) = 2.45063709469745e-2
          difference = 2.44610822875223e-2
n = 500 , left side = 7.24636777071908e-6
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.28966538751936e-2

```

$\cos(x)$

```

n = 10 , left side = 1.57869523854596e-7
          1/n^(7/10) = 1.99526231496888e-1
          difference = 1.99526073627364e-1
n = 20 , left side = 8.57307835911959e-10

```



```

1/n^(7/10) = 1.22822802611579e-1
difference = 1.22822801754271e-1
n = 50 , left side = 1.66778327101737e-10
1/n^(7/10) = 6.46727006577358e-2
difference = 6.46727004909574e-2
n = 100 , left side = 1.61355729577713e-10
1/n^(7/10) = 3.98107170553497e-2
difference = 3.98107168939940e-2
n = 200 , left side = 1.41525502993151e-10
1/n^(7/10) = 2.45063709469745e-2
difference = 2.45063708054490e-2
n = 500 , left side = 4.01468513110386e-11
1/n^(7/10) = 1.29039002429643e-2
difference = 1.29039002028175e-2

```

-----  
 $x_0 = 3/4\pi$ , Power = 3/10, lamda = 1/4, q = 1/4  
 -----

```

sin(x)

n = 10 , left side = 1.98204373198907e-1
1/n^(3/10) = 5.01187233627272e-1
difference = 3.02982860428365e-1
n = 20 , left side = 1.96093741108132e-1
1/n^(3/10) = 4.07090531536904e-1
difference = 2.10996790428773e-1
n = 50 , left side = 8.90320175478233e-2
1/n^(3/10) = 3.09249494710992e-1
difference = 2.20217477163168e-1
n = 100 , left side = 4.20399709374283e-2
1/n^(3/10) = 2.51188643150958e-1
difference = 2.09148672213530e-1
n = 200 , left side = 2.03292531654996e-2
1/n^(3/10) = 2.04028577336837e-1

```

```

        difference = 1.83699324171337e-1
n = 500 , left side = 7.95946134048608e-3
        1/n^(3/10) = 1.54991898754834e-1
        difference = 1.47032437414348e-1

```

$\cos(x)$

```

n = 10 , left side = 2.08515361670426e-2
        1/n^(3/10) = 5.01187233627272e-1
        difference = 4.80335697460230e-1
n = 20 , left side = 9.88652172815406e-2
        1/n^(3/10) = 4.07090531536904e-1
        difference = 3.08225314255364e-1
n = 50 , left side = 6.56587485923281e-2
        1/n^(3/10) = 3.09249494710992e-1
        difference = 2.43590746118664e-1
n = 100 , left side = 3.61332742512769e-2
        1/n^(3/10) = 2.51188643150958e-1
        difference = 2.15055368899681e-1
n = 200 , left side = 1.88501016814133e-2
        1/n^(3/10) = 2.04028577336837e-1
        difference = 1.85178475655424e-1
n = 500 , left side = 7.72268598453885e-3
        1/n^(3/10) = 1.54991898754834e-1
        difference = 1.47269212770295e-1

```

-----  
 $x_0 = 3/4\pi$ , Power = 3/10, lamda = 1/4, q = 1/2  
 -----

$\sin(x)$

```

n = 10 , left side = 1.16451550382340e-1
        1/n^(3/10) = 5.01187233627272e-1
        difference = 3.84735683244932e-1

```

```

n = 20 , left side = 1.10466828745202e-1
          1/n^(3/10) = 4.07090531536904e-1
          difference = 2.96623702791702e-1
n = 50 , left side = 4.72158292711957e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.62033665439796e-1
n = 100 , left side = 2.16912350736221e-2
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.29497408077336e-1
n = 200 , left side = 1.03316679895289e-2
          1/n^(3/10) = 2.04028577336837e-1
          difference = 1.93696909347308e-1
n = 500 , left side = 4.00637442698637e-3
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.50985524327847e-1

```

$\cos(x)$

```

n = 10 , left side = 7.05368783489744e-2
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.30650355278298e-1
n = 20 , left side = 3.11241153770572e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.75966416159847e-1
n = 50 , left side = 3.02411171988277e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.79008377512164e-1
n = 100 , left side = 1.74104155500615e-2
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.33778227600897e-1
n = 200 , left side = 9.25989196858301e-3
          1/n^(3/10) = 2.04028577336837e-1
          difference = 1.94768685368254e-1
n = 500 , left side = 3.83481978962918e-3
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.51157078965205e-1

```

-----  
 $x_0 = 3/4\pi$ , Power = 3/10, lamda = 1/4, q = 1  
 -----

$\sin(x)$

```

n = 10 , left side = 2.99818810563318e-2
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.71205352570941e-1
n = 20 , left side = 2.65906171704119e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.80499914366493e-1
n = 50 , left side = 7.39731951736688e-3
          1/n^(3/10) = 3.09249494710992e-1
          difference = 3.01852175193625e-1
n = 100 , left side = 1.86935956423195e-3
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.49319283586726e-1
n = 200 , left side = 4.67987750301657e-4
          1/n^(3/10) = 2.04028577336837e-1
          difference = 2.03560589586535e-1
n = 500 , left side = 7.49070874981328e-5
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.54916991667336e-1

```

$\cos(x)$

```

n = 10 , left side = 1.98513950706237e-1
          1/n^(3/10) = 5.01187233627272e-1
          difference = 3.02673282921035e-1
n = 20 , left side = 5.12486343061099e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.55841897230795e-1
n = 50 , left side = 7.45077142524186e-3

```

```

1/n^(3/10) = 3.09249494710992e-1
difference = 3.01798723285750e-1
n = 100 , left side = 1.86936242723723e-3
1/n^(3/10) = 2.51188643150958e-1
difference = 2.49319280723721e-1
n = 200 , left side = 4.67987750301213e-4
1/n^(3/10) = 2.04028577336837e-1
difference = 2.03560589586536e-1
n = 500 , left side = 7.49070874971336e-5
1/n^(3/10) = 1.54991898754834e-1
difference = 1.54916991667337e-1

```

-----  
 $x_0 = 3/4\pi$ , Power = 3/10, lamda = 1/2, q = 1/4  
 -----

$\sin(x)$

```

n = 10 , left side = 2.00168857534962e-1
1/n^(3/10) = 5.01187233627272e-1
difference = 3.01018376092311e-1
n = 20 , left side = 1.13262072722325e-1
1/n^(3/10) = 4.07090531536904e-1
difference = 2.93828458814580e-1
n = 50 , left side = 4.20732246994345e-2
1/n^(3/10) = 3.09249494710992e-1
difference = 2.67176270011557e-1
n = 100 , left side = 2.03378378667145e-2
1/n^(3/10) = 2.51188643150958e-1
difference = 2.30850805284244e-1
n = 200 , left side = 9.98779497231361e-3
1/n^(3/10) = 2.04028577336837e-1
difference = 1.94040782364523e-1
n = 500 , left side = 3.95085911348814e-3
1/n^(3/10) = 1.54991898754834e-1

```

difference = 1.51041039641346e-1

$\cos(x)$

n = 10 , left side = 9.93951714238188e-2  
1/n^(3/10) = 5.01187233627272e-1  
difference = 4.01792062203454e-1  
n = 20 , left side = 7.72328322774641e-2  
1/n^(3/10) = 4.07090531536904e-1  
difference = 3.29857699259440e-1  
n = 50 , left side = 3.60961128316282e-2  
1/n^(3/10) = 3.09249494710992e-1  
difference = 2.73153381879364e-1  
n = 100 , left side = 1.88410272392819e-2  
1/n^(3/10) = 2.51188643150958e-1  
difference = 2.32347615911676e-1  
n = 200 , left side = 9.61343382830915e-3  
1/n^(3/10) = 2.04028577336837e-1  
difference = 1.94415143508528e-1  
n = 500 , left side = 3.89095422715413e-3  
1/n^(3/10) = 1.54991898754834e-1  
difference = 1.51100944527680e-1

-----  
x0 = 3/4\*pi, Power = 3/10, lamda = 1/2, q = 1/2  
-----

$\sin(x)$

n = 10 , left side = 1.13322309591825e-1  
1/n^(3/10) = 5.01187233627272e-1  
difference = 3.87864924035447e-1  
n = 20 , left side = 6.09253390188929e-2  
1/n^(3/10) = 4.07090531536904e-1  
difference = 3.46165192518012e-1

```

n = 50 , left side = 2.17255059254715e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.87523988785520e-1
n = 100 , left side = 1.03403776602988e-2
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.40848265490659e-1
n = 200 , left side = 5.03665536910625e-3
          1/n^(3/10) = 2.04028577336837e-1
          difference = 1.98991921967731e-1
n = 500 , left side = 1.98226000171697e-3
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.53009638753117e-1

```

$\cos(x)$

```

n = 10 , left side = 3.12663766609829e-2
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.69920856966289e-1
n = 20 , left side = 3.44627783783419e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.72627753158563e-1
n = 50 , left side = 1.73741901387924e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.91875304572199e-1
n = 100 , left side = 9.25093740382410e-3
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.41937705747134e-1
n = 200 , left side = 4.76419447265497e-3
          1/n^(3/10) = 2.04028577336837e-1
          difference = 1.99264382864182e-1
n = 500 , left side = 1.93866173914381e-3
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.53053237015690e-1

```

-----

$x_0 = 3/4\pi$ , Power = 3/10, lamda = 1/2, q = 1

---

$\sin(x)$

```
n = 10 , left side = 2.86823828109785e-2
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.72504850816294e-1
n = 20 , left side = 1.14200334403045e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.95670498096600e-1
n = 50 , left side = 1.90462132680702e-3
          1/n^(3/10) = 3.09249494710992e-1
          difference = 3.07344873384185e-1
n = 100 , left side = 4.76820716816984e-4
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.50711822434141e-1
n = 200 , left side = 1.19246801639328e-4
          1/n^(3/10) = 2.04028577336837e-1
          difference = 2.03909330535198e-1
n = 500 , left side = 1.90813536953272e-5
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.54972817401138e-1
```

$\cos(x)$

```
n = 10 , left side = 5.13589058368011e-2
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.49828327790471e-1
n = 20 , left side = 1.19286950374290e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.95161836499475e-1
n = 50 , left side = 1.90462392585300e-3
          1/n^(3/10) = 3.09249494710992e-1
          difference = 3.07344870785139e-1
n = 100 , left side = 4.76820716817539e-4
```



```

1/n^(3/10) = 2.51188643150958e-1
difference = 2.50711822434140e-1
n = 200 , left side = 1.19246801639328e-4
1/n^(3/10) = 2.04028577336837e-1
difference = 2.03909330535198e-1
n = 500 , left side = 1.90813536955492e-5
1/n^(3/10) = 1.54991898754834e-1
difference = 1.54972817401138e-1

```

---

```

x0 = 3/4*pi, Power = 3/10, lamda = 1, q = 1/4

```

---

$\sin(x)$

```

n = 10 , left side = 1.14144646548721e-1
1/n^(3/10) = 5.01187233627272e-1
difference = 3.87042587078551e-1
n = 20 , left side = 5.36350821680255e-2
1/n^(3/10) = 4.07090531536904e-1
difference = 3.53455449368879e-1
n = 50 , left side = 2.03721764988825e-2
1/n^(3/10) = 3.09249494710992e-1
difference = 2.88877318212109e-1
n = 100 , left side = 9.99650895754667e-3
1/n^(3/10) = 2.51188643150958e-1
difference = 2.41192134193411e-1
n = 200 , left side = 4.95003907205904e-3
1/n^(3/10) = 2.04028577336837e-1
difference = 1.99078538264778e-1
n = 500 , left side = 1.96834136039681e-3
1/n^(3/10) = 1.54991898754834e-1
difference = 1.53023557394437e-1

```

$\cos(x)$

```

n = 10 , left side = 7.63132390190498e-2
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.24873994608223e-1
n = 20 , left side = 4.38690929008562e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.63221438636048e-1
n = 50 , left side = 1.88047305777049e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.90444764133287e-1
n = 100 , left side = 9.60447484518001e-3
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.41584168305778e-1
n = 200 , left side = 4.85201975765448e-3
          1/n^(3/10) = 2.04028577336837e-1
          difference = 1.99176557579182e-1
n = 500 , left side = 1.95265778643017e-3
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.53039240968404e-1

```

-----  
 $x_0 = 3/4\pi$ , Power = 3/10, lamda = 1, q = 1/2  
 -----

$\sin(x)$

```

n = 10 , left side = 6.18104658618466e-2
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.39376767765426e-1
n = 20 , left side = 2.80061711992697e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.79084360337635e-1
n = 50 , left side = 1.03752156519759e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.98874279059016e-1
n = 100 , left side = 5.04543144574432e-3

```

```

1/n^(3/10) = 2.51188643150958e-1
difference = 2.46143211705214e-1
n = 200 , left side = 2.48679978426469e-3
1/n^(3/10) = 2.04028577336837e-1
difference = 2.01541777552572e-1
n = 500 , left side = 9.86054094335276e-4
1/n^(3/10) = 1.54991898754834e-1
difference = 1.54005844660498e-1

```

$\cos(x)$

```

n = 10 , left side = 3.35723331340524e-2
1/n^(3/10) = 5.01187233627272e-1
difference = 4.67614900493220e-1
n = 20 , left side = 2.07751849096547e-2
1/n^(3/10) = 4.07090531536904e-1
difference = 3.86315346627250e-1
n = 50 , left side = 9.21511983819834e-3
1/n^(3/10) = 3.09249494710992e-1
difference = 3.00034374872793e-1
n = 100 , left side = 4.75529632502614e-3
1/n^(3/10) = 2.51188643150958e-1
difference = 2.46433346825932e-1
n = 200 , left side = 2.41425905034909e-3
1/n^(3/10) = 2.04028577336837e-1
difference = 2.01614318286488e-1
n = 500 , left side = 9.74447265982614e-4
1/n^(3/10) = 1.54991898754834e-1
difference = 1.54017451488851e-1

```

-----  
 $x_0 = 3/4\pi$ , Power = 3/10, lamda = 1, q = 1  
 -----

$\sin(x)$

$n = 10$  , left side =  $1.23317176677876e-2$   
 $1/n^{(3/10)} = 5.01187233627272e-1$   
difference =  $4.88855515959485e-1$   
 $n = 20$  , left side =  $3.19271958223943e-3$   
 $1/n^{(3/10)} = 4.07090531536904e-1$   
difference =  $4.03897811954665e-1$   
 $n = 50$  , left side =  $5.12151488168855e-4$   
 $1/n^{(3/10)} = 3.09249494710992e-1$   
difference =  $3.08737343222823e-1$   
 $n = 100$  , left side =  $1.28083959738623e-4$   
 $1/n^{(3/10)} = 2.51188643150958e-1$   
difference =  $2.51060559191219e-1$   
 $n = 200$  , left side =  $3.20240359168444e-5$   
 $1/n^{(3/10)} = 2.04028577336837e-1$   
difference =  $2.03996553300920e-1$   
 $n = 500$  , left side =  $5.12398354990395e-6$   
 $1/n^{(3/10)} = 1.54991898754834e-1$   
difference =  $1.54986774771284e-1$

$$\cos(x)$$

$n = 10$  , left side =  $1.27760703918799e-2$   
 $1/n^{(3/10)} = 5.01187233627272e-1$   
difference =  $4.88411163235392e-1$   
 $n = 20$  , left side =  $3.19296312784900e-3$   
 $1/n^{(3/10)} = 4.07090531536904e-1$   
difference =  $4.03897568409055e-1$   
 $n = 50$  , left side =  $5.12152374567032e-4$   
 $1/n^{(3/10)} = 3.09249494710992e-1$   
difference =  $3.08737342336425e-1$   
 $n = 100$  , left side =  $1.28084284152674e-4$   
 $1/n^{(3/10)} = 2.51188643150958e-1$   
difference =  $2.51060558866805e-1$   
 $n = 200$  , left side =  $3.20237987470051e-5$   
 $1/n^{(3/10)} = 2.04028577336837e-1$   
difference =  $2.03996553538090e-1$

```

n = 500 , left side = 5.12392899798542e-6
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.54986774825836e-1

```

```

-----
x0 = 3/4*pi, Power = 1/2, lamda = 1/4,  q = 1/4
-----

```

$\sin(x)$

```

n = 10 , left side = 1.98204373198907e-1
          1/n^(1/2) = 3.16227766016838e-1
          difference = 1.18023392817931e-1
n = 20 , left side = 1.96093741108132e-1
          1/n^(1/2) = 2.23606797749979e-1
          difference = 2.75130566418472e-2
n = 50 , left side = 8.90320175478233e-2
          1/n^(1/2) = 1.41421356237310e-1
          difference = 5.23893386894862e-2
n = 100 , left side = 4.20399709374283e-2
          1/n^(1/2) = 1.00000000000000e-1
          difference = 5.79600290625717e-2
n = 200 , left side = 2.03292531654996e-2
          1/n^(1/2) = 7.07106781186548e-2
          difference = 5.03814249531551e-2
n = 500 , left side = 7.95946134048608e-3
          1/n^(1/2) = 4.47213595499958e-2
          difference = 3.67618982095097e-2

```

$\cos(x)$

```

n = 10 , left side = 2.08515361670426e-2
          1/n^(1/2) = 3.16227766016838e-1
          difference = 2.95376229849795e-1
n = 20 , left side = 9.88652172815406e-2

```

```

1/n^(1/2) = 2.23606797749979e-1
difference = 1.24741580468438e-1
n = 50 , left side = 6.56587485923281e-2
1/n^(1/2) = 1.41421356237310e-1
difference = 7.57626076449814e-2
n = 100 , left side = 3.61332742512769e-2
1/n^(1/2) = 1.00000000000000e-1
difference = 6.38667257487231e-2
n = 200 , left side = 1.88501016814133e-2
1/n^(1/2) = 7.07106781186548e-2
difference = 5.18605764372414e-2
n = 500 , left side = 7.72268598453885e-3
1/n^(1/2) = 4.47213595499958e-2
difference = 3.69986735654569e-2

```

-----  
 $x_0 = 3/4\pi$ , Power = 1/2, lamda = 1/4, q = 1/2  
 -----

```

sin(x)
n = 10 , left side = 1.16451550382340e-1
1/n^(1/2) = 3.16227766016838e-1
difference = 1.99776215634498e-1
n = 20 , left side = 1.10466828745202e-1
1/n^(1/2) = 2.23606797749979e-1
difference = 1.13139969004777e-1
n = 50 , left side = 4.72158292711957e-2
1/n^(1/2) = 1.41421356237310e-1
difference = 9.42055269661138e-2
n = 100 , left side = 2.16912350736221e-2
1/n^(1/2) = 1.00000000000000e-1
difference = 7.83087649263779e-2
n = 200 , left side = 1.03316679895289e-2
1/n^(1/2) = 7.07106781186548e-2

```

```

        difference = 6.03790101291259e-2
n = 500 , left side = 4.00637442698637e-3
        1/n^(1/2) = 4.47213595499958e-2
        difference = 4.07149851230094e-2

```

$\cos(x)$

```

n = 10 , left side = 7.05368783489744e-2
        1/n^(1/2) = 3.16227766016838e-1
        difference = 2.45690887667864e-1
n = 20 , left side = 3.11241153770572e-2
        1/n^(1/2) = 2.23606797749979e-1
        difference = 1.92482682372922e-1
n = 50 , left side = 3.02411171988277e-2
        1/n^(1/2) = 1.41421356237310e-1
        difference = 1.11180239038482e-1
n = 100 , left side = 1.74104155500615e-2
        1/n^(1/2) = 1.00000000000000e-1
        difference = 8.25895844499385e-2
n = 200 , left side = 9.25989196858301e-3
        1/n^(1/2) = 7.07106781186548e-2
        difference = 6.14507861500717e-2
n = 500 , left side = 3.83481978962918e-3
        1/n^(1/2) = 4.47213595499958e-2
        difference = 4.08865397603666e-2

```

-----  
 $x_0 = 3/4\pi$ , Power = 1/2, lamda = 1/4, q = 1  
 -----

$\sin(x)$

```

n = 10 , left side = 2.99818810563318e-2
        1/n^(1/2) = 3.16227766016838e-1
        difference = 2.86245884960506e-1

```

$n = 20$  , left side = 2.65906171704119e-2  
 $1/n^{(1/2)} = 2.23606797749979e-1$   
difference = 1.97016180579567e-1  
 $n = 50$  , left side = 7.39731951736688e-3  
 $1/n^{(1/2)} = 1.41421356237310e-1$   
difference = 1.34024036719943e-1  
 $n = 100$  , left side = 1.86935956423195e-3  
 $1/n^{(1/2)} = 1.00000000000000e-1$   
difference = 9.81306404357681e-2  
 $n = 200$  , left side = 4.67987750301657e-4  
 $1/n^{(1/2)} = 7.07106781186548e-2$   
difference = 7.02426903683531e-2  
 $n = 500$  , left side = 7.49070874981328e-5  
 $1/n^{(1/2)} = 4.47213595499958e-2$   
difference = 4.46464524624977e-2

$\cos(x)$

$n = 10$  , left side = 1.98513950706237e-1  
 $1/n^{(1/2)} = 3.16227766016838e-1$   
difference = 1.17713815310601e-1  
 $n = 20$  , left side = 5.12486343061099e-2  
 $1/n^{(1/2)} = 2.23606797749979e-1$   
difference = 1.72358163443869e-1  
 $n = 50$  , left side = 7.45077142524186e-3  
 $1/n^{(1/2)} = 1.41421356237310e-1$   
difference = 1.33970584812068e-1  
 $n = 100$  , left side = 1.86936242723723e-3  
 $1/n^{(1/2)} = 1.00000000000000e-1$   
difference = 9.81306375727628e-2  
 $n = 200$  , left side = 4.67987750301213e-4  
 $1/n^{(1/2)} = 7.07106781186548e-2$   
difference = 7.02426903683535e-2  
 $n = 500$  , left side = 7.49070874971336e-5  
 $1/n^{(1/2)} = 4.47213595499958e-2$   
difference = 4.46464524624987e-2



-----  
 $x_0 = 3/4\pi$ , Power = 1/2, lamda = 1/2, q = 1/4  
 -----

$\sin(x)$

n = 10 , left side = 2.00168857534962e-1  
           1/n<sup>(1/2)</sup> = 3.16227766016838e-1  
           difference = 1.16058908481876e-1  
 n = 20 , left side = 1.13262072722325e-1  
           1/n<sup>(1/2)</sup> = 2.23606797749979e-1  
           difference = 1.10344725027654e-1  
 n = 50 , left side = 4.20732246994345e-2  
           1/n<sup>(1/2)</sup> = 1.41421356237310e-1  
           difference = 9.93481315378750e-2  
 n = 100 , left side = 2.03378378667145e-2  
           1/n<sup>(1/2)</sup> = 1.00000000000000e-1  
           difference = 7.96621621332855e-2  
 n = 200 , left side = 9.98779497231361e-3  
           1/n<sup>(1/2)</sup> = 7.07106781186548e-2  
           difference = 6.07228831463411e-2  
 n = 500 , left side = 3.95085911348814e-3  
           1/n<sup>(1/2)</sup> = 4.47213595499958e-2  
           difference = 4.07705004365077e-2

$\cos(x)$

n = 10 , left side = 9.93951714238188e-2  
           1/n<sup>(1/2)</sup> = 3.16227766016838e-1  
           difference = 2.16832594593019e-1  
 n = 20 , left side = 7.72328322774641e-2  
           1/n<sup>(1/2)</sup> = 2.23606797749979e-1  
           difference = 1.46373965472515e-1  
 n = 50 , left side = 3.60961128316282e-2

```

1/n^(1/2) = 1.41421356237310e-1
difference = 1.05325243405681e-1
n = 100 , left side = 1.88410272392819e-2
1/n^(1/2) = 1.00000000000000e-1
difference = 8.11589727607181e-2
n = 200 , left side = 9.61343382830915e-3
1/n^(1/2) = 7.07106781186548e-2
difference = 6.10972442903456e-2
n = 500 , left side = 3.89095422715413e-3
1/n^(1/2) = 4.47213595499958e-2
difference = 4.08304053228417e-2

```

-----  
 $x_0 = 3/4\pi$ , Power = 1/2, lamda = 1/2, q = 1/2  
 -----

$\sin(x)$

```

n = 10 , left side = 1.13322309591825e-1
1/n^(1/2) = 3.16227766016838e-1
difference = 2.02905456425013e-1
n = 20 , left side = 6.09253390188929e-2
1/n^(1/2) = 2.23606797749979e-1
difference = 1.62681458731086e-1
n = 50 , left side = 2.17255059254715e-2
1/n^(1/2) = 1.41421356237310e-1
difference = 1.19695850311838e-1
n = 100 , left side = 1.03403776602988e-2
1/n^(1/2) = 1.00000000000000e-1
difference = 8.96596223397012e-2
n = 200 , left side = 5.03665536910625e-3
1/n^(1/2) = 7.07106781186548e-2
difference = 6.56740227495485e-2
n = 500 , left side = 1.98226000171697e-3
1/n^(1/2) = 4.47213595499958e-2

```

difference = 4.27390995482788e-2

$\cos(x)$

n = 10 , left side = 3.12663766609829e-2  
1/n^(1/2) = 3.16227766016838e-1  
difference = 2.84961389355855e-1  
n = 20 , left side = 3.44627783783419e-2  
1/n^(1/2) = 2.23606797749979e-1  
difference = 1.89144019371637e-1  
n = 50 , left side = 1.73741901387924e-2  
1/n^(1/2) = 1.41421356237310e-1  
difference = 1.24047166098517e-1  
n = 100 , left side = 9.25093740382410e-3  
1/n^(1/2) = 1.00000000000000e-1  
difference = 9.07490625961759e-2  
n = 200 , left side = 4.76419447265497e-3  
1/n^(1/2) = 7.07106781186548e-2  
difference = 6.59464836459998e-2  
n = 500 , left side = 1.93866173914381e-3  
1/n^(1/2) = 4.47213595499958e-2  
difference = 4.27826978108520e-2

-----  
x0 = 3/4\*pi, Power = 1/2, lamda = 1/2, q = 1  
-----

$\sin(x)$

n = 10 , left side = 2.86823828109785e-2  
1/n^(1/2) = 3.16227766016838e-1  
difference = 2.87545383205859e-1  
n = 20 , left side = 1.14200334403045e-2  
1/n^(1/2) = 2.23606797749979e-1  
difference = 2.12186764309674e-1

```

n = 50 , left side = 1.90462132680702e-3
          1/n^(1/2) = 1.41421356237310e-1
          difference = 1.39516734910502e-1
n = 100 , left side = 4.76820716816984e-4
          1/n^(1/2) = 1.00000000000000e-1
          difference = 9.95231792831830e-2
n = 200 , left side = 1.19246801639328e-4
          1/n^(1/2) = 7.07106781186548e-2
          difference = 7.05914313170154e-2
n = 500 , left side = 1.90813536953272e-5
          1/n^(1/2) = 4.47213595499958e-2
          difference = 4.47022781963005e-2

```

$\cos(x)$

```

n = 10 , left side = 5.13589058368011e-2
          1/n^(1/2) = 3.16227766016838e-1
          difference = 2.64868860180037e-1
n = 20 , left side = 1.19286950374290e-2
          1/n^(1/2) = 2.23606797749979e-1
          difference = 2.11678102712550e-1
n = 50 , left side = 1.90462392585300e-3
          1/n^(1/2) = 1.41421356237310e-1
          difference = 1.39516732311457e-1
n = 100 , left side = 4.76820716817539e-4
          1/n^(1/2) = 1.00000000000000e-1
          difference = 9.95231792831825e-2
n = 200 , left side = 1.19246801639328e-4
          1/n^(1/2) = 7.07106781186548e-2
          difference = 7.05914313170154e-2
n = 500 , left side = 1.90813536955492e-5
          1/n^(1/2) = 4.47213595499958e-2
          difference = 4.47022781963002e-2

```

-----

$x_0 = 3/4\pi$ , Power = 1/2, lamda = 1, q = 1/4

---

$\sin(x)$

n = 10 , left side = 1.14144646548721e-1  
1/n^(1/2) = 3.16227766016838e-1  
difference = 2.02083119468117e-1  
n = 20 , left side = 5.36350821680255e-2  
1/n^(1/2) = 2.23606797749979e-1  
difference = 1.69971715581953e-1  
n = 50 , left side = 2.03721764988825e-2  
1/n^(1/2) = 1.41421356237310e-1  
difference = 1.21049179738427e-1  
n = 100 , left side = 9.99650895754667e-3  
1/n^(1/2) = 1.00000000000000e-1  
difference = 9.00034910424533e-2  
n = 200 , left side = 4.95003907205904e-3  
1/n^(1/2) = 7.07106781186548e-2  
difference = 6.57606390465957e-2  
n = 500 , left side = 1.96834136039681e-3  
1/n^(1/2) = 4.47213595499958e-2  
difference = 4.27530181895990e-2

$\cos(x)$

n = 10 , left side = 7.63132390190498e-2  
1/n^(1/2) = 3.16227766016838e-1  
difference = 2.39914526997788e-1  
n = 20 , left side = 4.38690929008562e-2  
1/n^(1/2) = 2.23606797749979e-1  
difference = 1.79737704849123e-1  
n = 50 , left side = 1.88047305777049e-2  
1/n^(1/2) = 1.41421356237310e-1  
difference = 1.22616625659605e-1  
n = 100 , left side = 9.60447484518001e-3

```

1/n^(1/2) = 1.000000000000000e-1
difference = 9.03955251548200e-2
n = 200 , left side = 4.85201975765448e-3
1/n^(1/2) = 7.07106781186548e-2
difference = 6.58586583610003e-2
n = 500 , left side = 1.95265778643017e-3
1/n^(1/2) = 4.47213595499958e-2
difference = 4.27687017635656e-2

```

-----  
 $x_0 = 3/4\pi$ , Power = 1/2, lamda = 1, q = 1/2  
 -----

$\sin(x)$

```

n = 10 , left side = 6.18104658618466e-2
1/n^(1/2) = 3.16227766016838e-1
difference = 2.54417300154991e-1
n = 20 , left side = 2.80061711992697e-2
1/n^(1/2) = 2.23606797749979e-1
difference = 1.95600626550709e-1
n = 50 , left side = 1.03752156519759e-2
1/n^(1/2) = 1.41421356237310e-1
difference = 1.31046140585334e-1
n = 100 , left side = 5.04543144574432e-3
1/n^(1/2) = 1.000000000000000e-1
difference = 9.49545685542557e-2
n = 200 , left side = 2.48679978426469e-3
1/n^(1/2) = 7.07106781186548e-2
difference = 6.82238783343901e-2
n = 500 , left side = 9.86054094335276e-4
1/n^(1/2) = 4.47213595499958e-2
difference = 4.37353054556605e-2

```

$\cos(x)$

```

n = 10 , left side = 3.35723331340524e-2
          1/n^(1/2) = 3.16227766016838e-1
          difference = 2.82655432882786e-1
n = 20 , left side = 2.07751849096547e-2
          1/n^(1/2) = 2.23606797749979e-1
          difference = 2.02831612840324e-1
n = 50 , left side = 9.21511983819834e-3
          1/n^(1/2) = 1.41421356237310e-1
          difference = 1.32206236399111e-1
n = 100 , left side = 4.75529632502614e-3
          1/n^(1/2) = 1.00000000000000e-1
          difference = 9.52447036749739e-2
n = 200 , left side = 2.41425905034909e-3
          1/n^(1/2) = 7.07106781186548e-2
          difference = 6.82964190683057e-2
n = 500 , left side = 9.74447265982614e-4
          1/n^(1/2) = 4.47213595499958e-2
          difference = 4.37469122840132e-2

```

```

-----
x0 = 3/4*pi, Power = 1/2, lamda = 1,  q = 1
-----

```

$\sin(x)$

```

n = 10 , left side = 1.23317176677876e-2
          1/n^(1/2) = 3.16227766016838e-1
          difference = 3.03896048349050e-1
n = 20 , left side = 3.19271958223943e-3
          1/n^(1/2) = 2.23606797749979e-1
          difference = 2.20414078167740e-1
n = 50 , left side = 5.12151488168855e-4
          1/n^(1/2) = 1.41421356237310e-1
          difference = 1.40909204749141e-1
n = 100 , left side = 1.28083959738623e-4

```

```

1/n^(1/2) = 1.000000000000000e-1
difference = 9.98719160402614e-2
n = 200 , left side = 3.20240359168444e-5
1/n^(1/2) = 7.07106781186548e-2
difference = 7.06786540827379e-2
n = 500 , left side = 5.12398354990395e-6
1/n^(1/2) = 4.47213595499958e-2
difference = 4.47162355664459e-2

```

$\cos(x)$

```

n = 10 , left side = 1.27760703918799e-2
1/n^(1/2) = 3.16227766016838e-1
difference = 3.03451695624958e-1
n = 20 , left side = 3.19296312784900e-3
1/n^(1/2) = 2.23606797749979e-1
difference = 2.20413834622130e-1
n = 50 , left side = 5.12152374567032e-4
1/n^(1/2) = 1.41421356237310e-1
difference = 1.40909203862742e-1
n = 100 , left side = 1.28084284152674e-4
1/n^(1/2) = 1.000000000000000e-1
difference = 9.98719157158473e-2
n = 200 , left side = 3.20237987470051e-5
1/n^(1/2) = 7.07106781186548e-2
difference = 7.06786543199077e-2
n = 500 , left side = 5.12392899798542e-6
1/n^(1/2) = 4.47213595499958e-2
difference = 4.47162356209978e-2

```

-----  
 $x_0 = 3/4\pi$ , Power = 7/10, lamda = 1/4, q = 1/4  
 -----

$\sin(x)$



$n = 10$  , left side =  $1.98204373198907e-1$   
 $1/n^{(7/10)} = 1.99526231496888e-1$   
difference =  $1.32185829798107e-3$   
 $n = 20$  , left side =  $1.96093741108132e-1$   
 $1/n^{(7/10)} = 1.22822802611579e-1$   
difference =  $-7.32709384965527e-2$   
 $n = 50$  , left side =  $8.90320175478233e-2$   
 $1/n^{(7/10)} = 6.46727006577358e-2$   
difference =  $-2.43593168900876e-2$   
 $n = 100$  , left side =  $4.20399709374283e-2$   
 $1/n^{(7/10)} = 3.98107170553497e-2$   
difference =  $-2.22925388207855e-3$   
 $n = 200$  , left side =  $2.03292531654996e-2$   
 $1/n^{(7/10)} = 2.45063709469745e-2$   
difference =  $4.17711778147490e-3$   
 $n = 500$  , left side =  $7.95946134048608e-3$   
 $1/n^{(7/10)} = 1.29039002429643e-2$   
difference =  $4.94443890247824e-3$

$$\cos(x)$$

$n = 10$  , left side =  $2.08515361670426e-2$   
 $1/n^{(7/10)} = 1.99526231496888e-1$   
difference =  $1.78674695329845e-1$   
 $n = 20$  , left side =  $9.88652172815406e-2$   
 $1/n^{(7/10)} = 1.22822802611579e-1$   
difference =  $2.39575853300384e-2$   
 $n = 50$  , left side =  $6.56587485923281e-2$   
 $1/n^{(7/10)} = 6.46727006577358e-2$   
difference =  $-9.86047934592366e-4$   
 $n = 100$  , left side =  $3.61332742512769e-2$   
 $1/n^{(7/10)} = 3.98107170553497e-2$   
difference =  $3.67744280407285e-3$   
 $n = 200$  , left side =  $1.88501016814133e-2$   
 $1/n^{(7/10)} = 2.45063709469745e-2$   
difference =  $5.65626926556118e-3$

```

n = 500 , left side = 7.72268598453885e-3
          1/n^(7/10) = 1.29039002429643e-2
          difference = 5.18121425842548e-3

```

```

-----
x0 = 3/4*pi, Power = 7/10, lamda = 1/4,  q = 1/2
-----

```

$\sin(x)$

```

n = 10 , left side = 1.16451550382340e-1
          1/n^(7/10) = 1.99526231496888e-1
          difference = 8.30746811145478e-2
n = 20 , left side = 1.10466828745202e-1
          1/n^(7/10) = 1.22822802611579e-1
          difference = 1.23559738663771e-2
n = 50 , left side = 4.72158292711957e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = 1.74568713865400e-2
n = 100 , left side = 2.16912350736221e-2
          1/n^(7/10) = 3.98107170553497e-2
          difference = 1.81194819817276e-2
n = 200 , left side = 1.03316679895289e-2
          1/n^(7/10) = 2.45063709469745e-2
          difference = 1.41747029574456e-2
n = 500 , left side = 4.00637442698637e-3
          1/n^(7/10) = 1.29039002429643e-2
          difference = 8.89752581597795e-3

```

$\cos(x)$

```

n = 10 , left side = 7.05368783489744e-2
          1/n^(7/10) = 1.99526231496888e-1
          difference = 1.28989353147914e-1
n = 20 , left side = 3.11241153770572e-2

```

```

1/n^(7/10) = 1.22822802611579e-1
difference = 9.16986872345219e-2
n = 50 , left side = 3.02411171988277e-2
1/n^(7/10) = 6.46727006577358e-2
difference = 3.44315834589080e-2
n = 100 , left side = 1.74104155500615e-2
1/n^(7/10) = 3.98107170553497e-2
difference = 2.24003015052882e-2
n = 200 , left side = 9.25989196858301e-3
1/n^(7/10) = 2.45063709469745e-2
difference = 1.52464789783915e-2
n = 500 , left side = 3.83481978962918e-3
1/n^(7/10) = 1.29039002429643e-2
difference = 9.06908045333514e-3

```

-----  
 $x_0 = 3/4\pi$ , Power = 7/10, lamda = 1/4, q = 1  
 -----

```

sin(x)

n = 10 , left side = 2.99818810563318e-2
1/n^(7/10) = 1.99526231496888e-1
difference = 1.69544350440556e-1
n = 20 , left side = 2.65906171704119e-2
1/n^(7/10) = 1.22822802611579e-1
difference = 9.62321854411672e-2
n = 50 , left side = 7.39731951736688e-3
1/n^(7/10) = 6.46727006577358e-2
difference = 5.72753811403689e-2
n = 100 , left side = 1.86935956423195e-3
1/n^(7/10) = 3.98107170553497e-2
difference = 3.79413574911178e-2
n = 200 , left side = 4.67987750301657e-4
1/n^(7/10) = 2.45063709469745e-2

```

```

difference = 2.40383831966728e-2
n = 500 , left side = 7.49070874981328e-5
1/n^(7/10) = 1.29039002429643e-2
difference = 1.28289931554662e-2

```

$\cos(x)$

```

n = 10 , left side = 1.98513950706237e-1
1/n^(7/10) = 1.99526231496888e-1
difference = 1.01228079065110e-3
n = 20 , left side = 5.12486343061099e-2
1/n^(7/10) = 1.22822802611579e-1
difference = 7.15741683054691e-2
n = 50 , left side = 7.45077142524186e-3
1/n^(7/10) = 6.46727006577358e-2
difference = 5.72219292324939e-2
n = 100 , left side = 1.86936242723723e-3
1/n^(7/10) = 3.98107170553497e-2
difference = 3.79413546281125e-2
n = 200 , left side = 4.67987750301213e-4
1/n^(7/10) = 2.45063709469745e-2
difference = 2.40383831966733e-2
n = 500 , left side = 7.49070874971336e-5
1/n^(7/10) = 1.29039002429643e-2
difference = 1.28289931554672e-2

```

-----  
 $x_0 = 3/4\pi$ , Power = 7/10, lamda = 1/2, q = 1/4  
 -----

$\sin(x)$

```

n = 10 , left side = 2.00168857534962e-1
1/n^(7/10) = 1.99526231496888e-1
difference = -6.42626038073607e-4

```

```

n = 20 , left side = 1.13262072722325e-1
          1/n^(7/10) = 1.22822802611579e-1
          difference = 9.56072988925447e-3
n = 50 , left side = 4.20732246994345e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = 2.25994759583012e-2
n = 100 , left side = 2.03378378667145e-2
          1/n^(7/10) = 3.98107170553497e-2
          difference = 1.94728791886352e-2
n = 200 , left side = 9.98779497231361e-3
          1/n^(7/10) = 2.45063709469745e-2
          difference = 1.45185759746609e-2
n = 500 , left side = 3.95085911348814e-3
          1/n^(7/10) = 1.29039002429643e-2
          difference = 8.95304112947619e-3

```

$\cos(x)$

```

n = 10 , left side = 9.93951714238188e-2
          1/n^(7/10) = 1.99526231496888e-1
          difference = 1.00131060073069e-1
n = 20 , left side = 7.72328322774641e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 4.55899703341149e-2
n = 50 , left side = 3.60961128316282e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = 2.85765878261076e-2
n = 100 , left side = 1.88410272392819e-2
          1/n^(7/10) = 3.98107170553497e-2
          difference = 2.09696898160678e-2
n = 200 , left side = 9.61343382830915e-3
          1/n^(7/10) = 2.45063709469745e-2
          difference = 1.48929371186654e-2
n = 500 , left side = 3.89095422715413e-3
          1/n^(7/10) = 1.29039002429643e-2
          difference = 9.01294601581019e-3

```

-----  
 $x_0 = 3/4\pi$ , Power = 7/10, lamda = 1/2, q = 1/2  
 -----

$\sin(x)$

```

n = 10 , left side = 1.13322309591825e-1
          1/n^(7/10) = 1.99526231496888e-1
          difference = 8.62039219050627e-2
n = 20 , left side = 6.09253390188929e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 6.18974635926862e-2
n = 50 , left side = 2.17255059254715e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = 4.29471947322642e-2
n = 100 , left side = 1.03403776602988e-2
          1/n^(7/10) = 3.98107170553497e-2
          difference = 2.94703393950509e-2
n = 200 , left side = 5.03665536910625e-3
          1/n^(7/10) = 2.45063709469745e-2
          difference = 1.94697155778683e-2
n = 500 , left side = 1.98226000171697e-3
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.09216402412474e-2

```

$\cos(x)$

```

n = 10 , left side = 3.12663766609829e-2
          1/n^(7/10) = 1.99526231496888e-1
          difference = 1.68259854835905e-1
n = 20 , left side = 3.44627783783419e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 8.83600242332372e-2
n = 50 , left side = 1.73741901387924e-2

```

```

1/n^(7/10) = 6.46727006577358e-2
difference = 4.72985105189434e-2
n = 100 , left side = 9.25093740382410e-3
1/n^(7/10) = 3.98107170553497e-2
difference = 3.05597796515256e-2
n = 200 , left side = 4.76419447265497e-3
1/n^(7/10) = 2.45063709469745e-2
difference = 1.97421764743195e-2
n = 500 , left side = 1.93866173914381e-3
1/n^(7/10) = 1.29039002429643e-2
difference = 1.09652385038205e-2

```

-----  
 $x_0 = 3/4\pi$ , Power = 7/10, lamda = 1/2, q = 1  
 -----

```

sin(x)
n = 10 , left side = 2.86823828109785e-2
1/n^(7/10) = 1.99526231496888e-1
difference = 1.70843848685910e-1
n = 20 , left side = 1.14200334403045e-2
1/n^(7/10) = 1.22822802611579e-1
difference = 1.11402769171275e-1
n = 50 , left side = 1.90462132680702e-3
1/n^(7/10) = 6.46727006577358e-2
difference = 6.27680793309287e-2
n = 100 , left side = 4.76820716816984e-4
1/n^(7/10) = 3.98107170553497e-2
difference = 3.93338963385328e-2
n = 200 , left side = 1.19246801639328e-4
1/n^(7/10) = 2.45063709469745e-2
difference = 2.43871241453352e-2
n = 500 , left side = 1.90813536953272e-5
1/n^(7/10) = 1.29039002429643e-2

```

difference = 1.28848188892690e-2

$\cos(x)$

n = 10 , left side = 5.13589058368011e-2  
1/n^(7/10) = 1.99526231496888e-1  
difference = 1.48167325660087e-1  
n = 20 , left side = 1.19286950374290e-2  
1/n^(7/10) = 1.22822802611579e-1  
difference = 1.10894107574150e-1  
n = 50 , left side = 1.90462392585300e-3  
1/n^(7/10) = 6.46727006577358e-2  
difference = 6.27680767318828e-2  
n = 100 , left side = 4.76820716817539e-4  
1/n^(7/10) = 3.98107170553497e-2  
difference = 3.93338963385322e-2  
n = 200 , left side = 1.19246801639328e-4  
1/n^(7/10) = 2.45063709469745e-2  
difference = 2.43871241453352e-2  
n = 500 , left side = 1.90813536955492e-5  
1/n^(7/10) = 1.29039002429643e-2  
difference = 1.28848188892688e-2

-----  
x0 = 3/4\*pi, Power = 7/10, lamda = 1, q = 1/4  
-----

$\sin(x)$

n = 10 , left side = 1.14144646548721e-1  
1/n^(7/10) = 1.99526231496888e-1  
difference = 8.53815849481670e-2  
n = 20 , left side = 5.36350821680255e-2  
1/n^(7/10) = 1.22822802611579e-1  
difference = 6.91877204435536e-2



```

n = 50 , left side = 2.03721764988825e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = 4.43005241588533e-2
n = 100 , left side = 9.99650895754667e-3
          1/n^(7/10) = 3.98107170553497e-2
          difference = 2.98142080978031e-2
n = 200 , left side = 4.95003907205904e-3
          1/n^(7/10) = 2.45063709469745e-2
          difference = 1.95563318749155e-2
n = 500 , left side = 1.96834136039681e-3
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.09355588825675e-2

```

$\cos(x)$

```

n = 10 , left side = 7.63132390190498e-2
          1/n^(7/10) = 1.99526231496888e-1
          difference = 1.23212992477838e-1
n = 20 , left side = 4.38690929008562e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 7.89537097107229e-2
n = 50 , left side = 1.88047305777049e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = 4.58679700800308e-2
n = 100 , left side = 9.60447484518001e-3
          1/n^(7/10) = 3.98107170553497e-2
          difference = 3.02062422101697e-2
n = 200 , left side = 4.85201975765448e-3
          1/n^(7/10) = 2.45063709469745e-2
          difference = 1.96543511893200e-2
n = 500 , left side = 1.95265778643017e-3
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.09512424565342e-2

```

-----

$x_0 = 3/4\pi$ , Power = 7/10, lamda = 1, q = 1/2

---

$\sin(x)$

n = 10 , left side = 6.18104658618466e-2  
1/n^(7/10) = 1.99526231496888e-1  
difference = 1.37715765635041e-1  
n = 20 , left side = 2.80061711992697e-2  
1/n^(7/10) = 1.22822802611579e-1  
difference = 9.48166314123093e-2  
n = 50 , left side = 1.03752156519759e-2  
1/n^(7/10) = 6.46727006577358e-2  
difference = 5.42974850057599e-2  
n = 100 , left side = 5.04543144574432e-3  
1/n^(7/10) = 3.98107170553497e-2  
difference = 3.47652856096054e-2  
n = 200 , left side = 2.48679978426469e-3  
1/n^(7/10) = 2.45063709469745e-2  
difference = 2.20195711627098e-2  
n = 500 , left side = 9.86054094335276e-4  
1/n^(7/10) = 1.29039002429643e-2  
difference = 1.19178461486290e-2

$\cos(x)$

n = 10 , left side = 3.35723331340524e-2  
1/n^(7/10) = 1.99526231496888e-1  
difference = 1.65953898362836e-1  
n = 20 , left side = 2.07751849096547e-2  
1/n^(7/10) = 1.22822802611579e-1  
difference = 1.02047617701924e-1  
n = 50 , left side = 9.21511983819834e-3  
1/n^(7/10) = 6.46727006577358e-2  
difference = 5.54575808195374e-2  
n = 100 , left side = 4.75529632502614e-3

```

1/n^(7/10) = 3.98107170553497e-2
difference = 3.50554207303236e-2
n = 200 , left side = 2.41425905034909e-3
1/n^(7/10) = 2.45063709469745e-2
difference = 2.20921118966254e-2
n = 500 , left side = 9.74447265982614e-4
1/n^(7/10) = 1.29039002429643e-2
difference = 1.19294529769817e-2

```

-----  
 $x_0 = 3/4\pi$ , Power = 7/10, lamda = 1, q = 1  
 -----

```

sin(x)

n = 10 , left side = 1.23317176677876e-2
1/n^(7/10) = 1.99526231496888e-1
difference = 1.87194513829100e-1
n = 20 , left side = 3.19271958223943e-3
1/n^(7/10) = 1.22822802611579e-1
difference = 1.19630083029340e-1
n = 50 , left side = 5.12151488168855e-4
1/n^(7/10) = 6.46727006577358e-2
difference = 6.41605491695669e-2
n = 100 , left side = 1.28083959738623e-4
1/n^(7/10) = 3.98107170553497e-2
difference = 3.96826330956111e-2
n = 200 , left side = 3.20240359168444e-5
1/n^(7/10) = 2.45063709469745e-2
difference = 2.44743469110577e-2
n = 500 , left side = 5.12398354990395e-6
1/n^(7/10) = 1.29039002429643e-2
difference = 1.28987762594144e-2

```

cos(x)

```

n = 10 , left side = 1.27760703918799e-2
           1/n^(7/10) = 1.99526231496888e-1
           difference = 1.86750161105008e-1
n = 20 , left side = 3.19296312784900e-3
           1/n^(7/10) = 1.22822802611579e-1
           difference = 1.19629839483730e-1
n = 50 , left side = 5.12152374567032e-4
           1/n^(7/10) = 6.46727006577358e-2
           difference = 6.41605482831687e-2
n = 100 , left side = 1.28084284152674e-4
           1/n^(7/10) = 3.98107170553497e-2
           difference = 3.96826327711971e-2
n = 200 , left side = 3.20237987470051e-5
           1/n^(7/10) = 2.45063709469745e-2
           difference = 2.44743471482275e-2
n = 500 , left side = 5.12392899798542e-6
           1/n^(7/10) = 1.29039002429643e-2
           difference = 1.28987763139663e-2

```

```

[ ]: RR.scientific_notation(True)
powers = [3/10, 1/2, 7/10]
lamdas = [1/4, 1/2, 1]    #deformation parameter lamda over (0, 1]
    ↪ 1] - these are the beta values in the formula
qs = [1/4, 1/2, 1]    #deformation coefficient

funcs = [x^(1/3), x, x^2, x^3, x^4, x^10]    #choice of functions
    ↪ functions
a = -1    #the interval
b = 1    #the interval
x0=1/2

for power in powers:
    ↪
    ↪ #####
        for lamda in lamdas:    #going over each lamda value

```

```

    □
    ↪ #####
        for q in qs:      #going over each q value
            □
            ↪ #####
                print()
                print()
            □
            ↪ print("-----")
                print("x0 = " + str(x0)+", Power = "+ str(power)+
            ↪ ", lamda = "+ str(lamda) + ", q = " + str(q))
            □
            ↪ print("-----")
                #the activation function
                phi(x) = (1-q*(e-lamda*x))/(1+q*(e-lamda*x))
            ↪ #formula 20.1

                #q-deformed and β-parametrized half hyperbolic
            ↪ tangent
                theta(x) = 1/4*(phi(x+1) - phi(x-1))      #formula
            ↪ 20.8

            □
            ↪ #####
                for i in range(len(funcs)):
                    □
                    ↪ #####
                        f(x)=funcs[i]
                        show(f(x))
                        for n in [10, 20, 50, 100, 200, 500]:
                            #def H(n, f, x):      #real-valued linear
            ↪ neural network operators
                            #      return sum(f(k/n)*theta(n*x-k) for k
            ↪ in [ceil(n*a),...,floor(n*b)])/sum(theta(n*x-k) for k in
            ↪ [ceil(n*a),...,floor(n*b)])

```

```

        #leftSide = abs(H(n,f,x0)-f(x0))
        leftSide = abs(sum(f(k/n)*theta(n*x0-k)
↪for k in [ceil(n*a),...,floor(n*b)]) / sum(theta(n*x0-k) for k
↪in [ceil(n*a),...,floor(n*b)]) - f(x0))

        val1 = n
        val2 = leftSide.n()
        val3 = 1/(n^power).n()
        print("                n = "+str(val1), " , left
↪side = "+str(val2), " \n                1/
↪n^("+str(power)+") = "+str(val3), " \n
↪difference = "+str(val3-val2))

```

-----  
x0 = 1/2, Power = 3/10, lamda = 1/4, q = 1/4  
-----

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 7.33574282376017e-2
        1/n^(3/10) = 5.01187233627272e-1
        difference = 4.27829805389671e-1
n = 20 , left side = 4.53841801182795e-2
        1/n^(3/10) = 4.07090531536904e-1
        difference = 3.61706351418625e-1
n = 50 , left side = 4.74957712877522e-2
        1/n^(3/10) = 3.09249494710992e-1
        difference = 2.61753723423239e-1
n = 100 , left side = 2.67013950556243e-2
        1/n^(3/10) = 2.51188643150958e-1
        difference = 2.24487248095334e-1
n = 200 , left side = 1.39773905392242e-2
        1/n^(3/10) = 2.04028577336837e-1
        difference = 1.90051186797613e-1

```

$n = 500$  , left side = 5.75326859927561e-3  
 $1/n^{(3/10)} = 1.54991898754834e-1$   
difference = 1.49238630155558e-1

$x$

$n = 10$  , left side = 1.48505389324612e-2  
 $1/n^{(3/10)} = 5.01187233627272e-1$   
difference = 4.86336694694811e-1  
 $n = 20$  , left side = 1.39174879467004e-1  
 $1/n^{(3/10)} = 4.07090531536904e-1$   
difference = 2.67915652069900e-1  
 $n = 50$  , left side = 1.07608816899145e-1  
 $1/n^{(3/10)} = 3.09249494710992e-1$   
difference = 2.01640677811846e-1  
 $n = 100$  , left side = 5.54452812788874e-2  
 $1/n^{(3/10)} = 2.51188643150958e-1$   
difference = 1.95743361872071e-1  
 $n = 200$  , left side = 2.77258871979472e-2  
 $1/n^{(3/10)} = 2.04028577336837e-1$   
difference = 1.76302690138890e-1  
 $n = 500$  , left side = 1.10903548889592e-2  
 $1/n^{(3/10)} = 1.54991898754834e-1$   
difference = 1.43901543865875e-1

$x^2$

$n = 10$  , left side = 1.94005188391137e-1  
 $1/n^{(3/10)} = 5.01187233627272e-1$   
difference = 3.07182045236135e-1  
 $n = 20$  , left side = 2.30868040947246e-1  
 $1/n^{(3/10)} = 4.07090531536904e-1$   
difference = 1.76222490589658e-1  
 $n = 50$  , left side = 1.38886956653740e-1  
 $1/n^{(3/10)} = 3.09249494710992e-1$   
difference = 1.70362538057252e-1

$n = 100$  , left side = 6.38134518553904e-2  
 $1/n^{(3/10)} = 2.51188643150958e-1$   
difference = 1.87375191295568e-1  
 $n = 200$  , left side = 2.98188925936178e-2  
 $1/n^{(3/10)} = 2.04028577336837e-1$   
difference = 1.74209684743219e-1  
 $n = 500$  , left side = 1.14252357544120e-2  
 $1/n^{(3/10)} = 1.54991898754834e-1$   
difference = 1.43566663000422e-1

$$x^3$$

$n = 10$  , left side = 2.06175421900515e-1  
 $1/n^{(3/10)} = 5.01187233627272e-1$   
difference = 2.95011811726758e-1  
 $n = 20$  , left side = 2.53575282932135e-1  
 $1/n^{(3/10)} = 4.07090531536904e-1$   
difference = 1.53515248604770e-1  
 $n = 50$  , left side = 1.34595194359457e-1  
 $1/n^{(3/10)} = 3.09249494710992e-1$   
difference = 1.74654300351535e-1  
 $n = 100$  , left side = 5.51857590364190e-2  
 $1/n^{(3/10)} = 2.51188643150958e-1$   
difference = 1.96002884114539e-1  
 $n = 200$  , left side = 2.40653876252187e-2  
 $1/n^{(3/10)} = 2.04028577336837e-1$   
difference = 1.79963189711618e-1  
 $n = 500$  , left side = 8.82850116987996e-3  
 $1/n^{(3/10)} = 1.54991898754834e-1$   
difference = 1.46163397584954e-1

$$x^4$$

$n = 10$  , left side = 2.45980444406422e-1  
 $1/n^{(3/10)} = 5.01187233627272e-1$   
difference = 2.55206789220850e-1



```

n = 20 , left side = 2.51901006172595e-1
          1/n^(3/10) = 4.07090531536904e-1
          difference = 1.55189525364309e-1
n = 50 , left side = 1.17335729825915e-1
          1/n^(3/10) = 3.09249494710992e-1
          difference = 1.91913764885076e-1
n = 100 , left side = 4.25973806719297e-2
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.08591262479028e-1
n = 200 , left side = 1.72794180717638e-2
          1/n^(3/10) = 2.04028577336837e-1
          difference = 1.86749159265073e-1
n = 500 , left side = 6.06468552840353e-3
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.48927213226430e-1

```

$$x^{10}$$

```

n = 10 , left side = 1.88296929722229e-1
          1/n^(3/10) = 5.01187233627272e-1
          difference = 3.12890303905044e-1
n = 20 , left side = 1.57124987034018e-1
          1/n^(3/10) = 4.07090531536904e-1
          difference = 2.49965544502886e-1
n = 50 , left side = 3.56919049916328e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.73557589719359e-1
n = 100 , left side = 4.80555765395147e-3
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.46383085497007e-1
n = 200 , left side = 1.09199033498743e-3
          1/n^(3/10) = 2.04028577336837e-1
          difference = 2.02936587001850e-1
n = 500 , left side = 2.84658201772995e-4
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.54707240553061e-1

```

-----  
x0 = 1/2, Power = 3/10, lamda = 1/4, q = 1/2  
-----

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 1.26504552641874e-1
          1/n^(3/10) = 5.01187233627272e-1
          difference = 3.74682680985398e-1
n = 20 , left side = 2.03548587742321e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.86735672762672e-1
n = 50 , left side = 2.03304570248800e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.88919037686112e-1
n = 100 , left side = 1.26409079150098e-2
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.38547735235948e-1
n = 200 , left side = 6.81868079261294e-3
          1/n^(3/10) = 2.04028577336837e-1
          difference = 1.97209896544224e-1
n = 500 , left side = 2.84988268112463e-3
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.52142016073709e-1

```

$$x$$

```

n = 10 , left side = 8.02267409115550e-2
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.20960492715717e-1
n = 20 , left side = 5.14929405767165e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.55597590960188e-1
n = 50 , left side = 5.36143926388598e-2

```

```

1/n^(3/10) = 3.09249494710992e-1
difference = 2.55635102072132e-1
n = 100 , left side = 2.77224568458393e-2
1/n^(3/10) = 2.51188643150958e-1
difference = 2.23466186305119e-1
n = 200 , left side = 1.38629435986308e-2
1/n^(3/10) = 2.04028577336837e-1
difference = 1.90165633738206e-1
n = 500 , left side = 5.54517744447935e-3
1/n^(3/10) = 1.54991898754834e-1
difference = 1.49446721310354e-1

```

$$x^2$$

```

n = 10 , left side = 1.28296366461717e-1
1/n^(3/10) = 5.01187233627272e-1
difference = 3.72890867165556e-1
n = 20 , left side = 1.38397942935223e-1
1/n^(3/10) = 4.07090531536904e-1
difference = 2.68692588601681e-1
n = 50 , left side = 7.67416652503929e-2
1/n^(3/10) = 3.09249494710992e-1
difference = 2.32507829460599e-1
n = 100 , left side = 3.37863631986791e-2
1/n^(3/10) = 2.51188643150958e-1
difference = 2.17402279952279e-1
n = 200 , left side = 1.53794053842907e-2
1/n^(3/10) = 2.04028577336837e-1
difference = 1.88649171952546e-1
n = 500 , left side = 5.78781133126016e-3
1/n^(3/10) = 1.54991898754834e-1
difference = 1.49204087423574e-1

```

$$x^3$$

```

n = 10 , left side = 1.27831704419723e-1

```

```

1/n^(3/10) = 5.01187233627272e-1
difference = 3.73355529207549e-1
n = 20 , left side = 1.61344011208260e-1
1/n^(3/10) = 4.07090531536904e-1
difference = 2.45746520328645e-1
n = 50 , left side = 7.78602100423141e-2
1/n^(3/10) = 3.09249494710992e-1
difference = 2.31389284668678e-1
n = 100 , left side = 3.03485286276982e-2
1/n^(3/10) = 2.51188643150958e-1
difference = 2.20840114523260e-1
n = 200 , left side = 1.27296398524397e-2
1/n^(3/10) = 2.04028577336837e-1
difference = 1.91298937484397e-1
n = 500 , left side = 4.52652924015576e-3
1/n^(3/10) = 1.54991898754834e-1
difference = 1.50465369514678e-1

```

$$x^4$$

```

n = 10 , left side = 1.84494512877635e-1
1/n^(3/10) = 5.01187233627272e-1
difference = 3.16692720749638e-1
n = 20 , left side = 1.66506805511951e-1
1/n^(3/10) = 4.07090531536904e-1
difference = 2.40583726024953e-1
n = 50 , left side = 6.92290642748952e-2
1/n^(3/10) = 3.09249494710992e-1
difference = 2.40020430436097e-1
n = 100 , left side = 2.40205845419831e-2
1/n^(3/10) = 2.51188643150958e-1
difference = 2.27168058608975e-1
n = 200 , left side = 9.33054650504601e-3
1/n^(3/10) = 2.04028577336837e-1
difference = 1.94698030831791e-1
n = 500 , left side = 3.14415812448704e-3

```

$1/n^{(3/10)} = 1.54991898754834e-1$   
 $\text{difference} = 1.51847740630347e-1$

$$x^{10}$$

$n = 10$  , left side =  $1.40771586828727e-1$   
 $1/n^{(3/10)} = 5.01187233627272e-1$   
 $\text{difference} = 3.60415646798545e-1$   
 $n = 20$  , left side =  $1.00214745282116e-1$   
 $1/n^{(3/10)} = 4.07090531536904e-1$   
 $\text{difference} = 3.06875786254789e-1$   
 $n = 50$  , left side =  $1.99853845577975e-2$   
 $1/n^{(3/10)} = 3.09249494710992e-1$   
 $\text{difference} = 2.89264110153194e-1$   
 $n = 100$  , left side =  $2.75646208624215e-3$   
 $1/n^{(3/10)} = 2.51188643150958e-1$   
 $\text{difference} = 2.48432181064716e-1$   
 $n = 200$  , left side =  $6.26624240120877e-4$   
 $1/n^{(3/10)} = 2.04028577336837e-1$   
 $\text{difference} = 2.03401953096716e-1$   
 $n = 500$  , left side =  $1.55217235579062e-4$   
 $1/n^{(3/10)} = 1.54991898754834e-1$   
 $\text{difference} = 1.54836681519255e-1$

-----  
 $x_0 = 1/2$ , Power =  $3/10$ , lamda =  $1/4$ ,  $q = 1$   
 -----

$$x^{\frac{1}{3}}$$

$n = 10$  , left side =  $2.09749541545875e-1$   
 $1/n^{(3/10)} = 5.01187233627272e-1$   
 $\text{difference} = 2.91437692081397e-1$   
 $n = 20$  , left side =  $7.85812770396360e-2$   
 $1/n^{(3/10)} = 4.07090531536904e-1$

```

        difference = 3.28509254497268e-1
n = 50 , left side = 9.34393044496805e-3
        1/n^(3/10) = 3.09249494710992e-1
        difference = 2.99905564266024e-1
n = 100 , left side = 1.94070471300620e-3
        1/n^(3/10) = 2.51188643150958e-1
        difference = 2.49247938437952e-1
n = 200 , left side = 4.71100029514671e-4
        1/n^(3/10) = 2.04028577336837e-1
        difference = 2.03557477307322e-1
n = 500 , left side = 7.48422627483425e-5
        1/n^(3/10) = 1.54991898754834e-1
        difference = 1.54917056492085e-1

```

$x$

```

n = 10 , left side = 2.08951638220122e-1
        1/n^(3/10) = 5.01187233627272e-1
        difference = 2.92235595407150e-1
n = 20 , left side = 5.25889244914822e-2
        1/n^(3/10) = 4.07090531536904e-1
        difference = 3.54501607045422e-1
n = 50 , left side = 1.01379455384021e-3
        1/n^(3/10) = 3.09249494710992e-1
        difference = 3.08235700157152e-1
n = 100 , left side = 1.80708522862227e-6
        1/n^(3/10) = 2.51188643150958e-1
        difference = 2.51186836065729e-1
n = 200 , left side = 6.45467013171697e-12
        1/n^(3/10) = 2.04028577336837e-1
        difference = 2.04028577330382e-1
n = 500 , left side = 0.000000000000000e0
        1/n^(3/10) = 1.54991898754834e-1
        difference = 1.54991898754834e-1

```

$x^2$

$n = 10$  , left side = 6.09251809834974e-2  
 $1/n^{(3/10)} = 5.01187233627272e-1$   
difference = 4.40262052643775e-1  
 $n = 20$  , left side = 4.57428235934711e-2  
 $1/n^{(3/10)} = 4.07090531536904e-1$   
difference = 3.61347707943433e-1  
 $n = 50$  , left side = 1.96014797649490e-2  
 $1/n^{(3/10)} = 3.09249494710992e-1$   
difference = 2.89648014946043e-1  
 $n = 100$  , left side = 5.29434230595233e-3  
 $1/n^{(3/10)} = 2.51188643150958e-1$   
difference = 2.45894300845006e-1  
 $n = 200$  , left side = 1.32428057699463e-3  
 $1/n^{(3/10)} = 2.04028577336837e-1$   
difference = 2.02704296759842e-1  
 $n = 500$  , left side = 2.11884893889736e-4  
 $1/n^{(3/10)} = 1.54991898754834e-1$   
difference = 1.54780013860944e-1

$$x^3$$

$n = 10$  , left side = 3.81659578000774e-2  
 $1/n^{(3/10)} = 5.01187233627272e-1$   
difference = 4.63021275827195e-1  
 $n = 20$  , left side = 7.43081431790645e-2  
 $1/n^{(3/10)} = 4.07090531536904e-1$   
difference = 3.32782388357840e-1  
 $n = 50$  , left side = 2.97879650699726e-2  
 $1/n^{(3/10)} = 3.09249494710992e-1$   
difference = 2.79461529641019e-1  
 $n = 100$  , left side = 7.94232255998317e-3  
 $1/n^{(3/10)} = 2.51188643150958e-1$   
difference = 2.43246320590975e-1  
 $n = 200$  , left side = 1.98642086856246e-3  
 $1/n^{(3/10)} = 2.04028577336837e-1$   
difference = 2.02042156468275e-1

n = 500 , left side = 3.17827340834853e-4  
 1/n^(3/10) = 1.54991898754834e-1  
 difference = 1.54674071413999e-1

$$x^4$$

n = 10 , left side = 1.25757444757586e-1  
 1/n^(3/10) = 5.01187233627272e-1  
 difference = 3.75429788869686e-1  
 n = 20 , left side = 9.19703672747021e-2  
 1/n^(3/10) = 4.07090531536904e-1  
 difference = 3.15120164262202e-1  
 n = 50 , left side = 3.13124123712135e-2  
 1/n^(3/10) = 3.09249494710992e-1  
 difference = 2.77937082339778e-1  
 n = 100 , left side = 8.05935138518928e-3  
 1/n^(3/10) = 2.51188643150958e-1  
 difference = 2.43129291765769e-1  
 n = 200 , left side = 1.99376000196878e-3  
 1/n^(3/10) = 2.04028577336837e-1  
 difference = 2.02034817334868e-1  
 n = 500 , left side = 3.18015222677798e-4  
 1/n^(3/10) = 1.54991898754834e-1  
 difference = 1.54673883532156e-1

$$x^{10}$$

n = 10 , left side = 9.92211518367574e-2  
 1/n^(3/10) = 5.01187233627272e-1  
 difference = 4.01966081790515e-1  
 n = 20 , left side = 5.87860822296067e-2  
 1/n^(3/10) = 4.07090531536904e-1  
 difference = 3.48304449307298e-1  
 n = 50 , left side = 1.06402237950819e-2  
 1/n^(3/10) = 3.09249494710992e-1  
 difference = 2.98609270915910e-1



```

n = 100 , left side = 1.39397823915505e-3
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.49794664911803e-1
n = 200 , left side = 2.58092754851807e-4
          1/n^(3/10) = 2.04028577336837e-1
          difference = 2.03770484581985e-1
n = 500 , left side = 3.78668260722235e-5
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.54954031928761e-1

```

-----  
x0 = 1/2, Power = 3/10, lamda = 1/2, q = 1/4  
-----

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 4.65939350634126e-2
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.54593298563860e-1
n = 20 , left side = 5.39175273339060e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.53173004202998e-1
n = 50 , left side = 2.66706958509519e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.82578798860040e-1
n = 100 , left side = 1.39692422376499e-2
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.37219400913308e-1
n = 200 , left side = 7.15466879542803e-3
          1/n^(3/10) = 2.04028577336837e-1
          difference = 1.96873908541409e-1
n = 500 , left side = 2.90466167844949e-3
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.52087237076384e-1

```

$x$

```
n = 10 , left side = 1.46960541508878e-1
          1/n^(3/10) = 5.01187233627272e-1
          difference = 3.54226692118394e-1
n = 20 , left side = 1.28044818944893e-1
          1/n^(3/10) = 4.07090531536904e-1
          difference = 2.79045712592011e-1
n = 50 , left side = 5.54458428059441e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.53803651905048e-1
n = 100 , left side = 2.77258872001895e-2
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.23462755950768e-1
n = 200 , left side = 1.38629436111990e-2
          1/n^(3/10) = 2.04028577336837e-1
          difference = 1.90165633725638e-1
n = 500 , left side = 5.54517744447969e-3
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.49446721310354e-1
```

$x^2$

```
n = 10 , left side = 2.44068957215094e-1
          1/n^(3/10) = 5.01187233627272e-1
          difference = 2.57118276412179e-1
n = 20 , left side = 1.73393496362237e-1
          1/n^(3/10) = 4.07090531536904e-1
          difference = 2.33697035174667e-1
n = 50 , left side = 6.39143140576404e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.45335180653351e-1
n = 100 , left side = 2.98438925970290e-2
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.21344750553929e-1
n = 200 , left side = 1.43924449634690e-2
```

```

1/n^(3/10) = 2.04028577336837e-1
difference = 1.89636132373368e-1
n = 500 , left side = 5.62989766084282e-3
1/n^(3/10) = 1.54991898754834e-1
difference = 1.49362001093991e-1

```

$$x^3$$

```

n = 10 , left side = 2.70532081486956e-1
1/n^(3/10) = 5.01187233627272e-1
difference = 2.30655152140316e-1
n = 20 , left side = 1.75303858260733e-1
1/n^(3/10) = 4.07090531536904e-1
difference = 2.31786673276172e-1
n = 50 , left side = 5.53534166881952e-2
1/n^(3/10) = 3.09249494710992e-1
difference = 2.53896078022797e-1
n = 100 , left side = 2.41049670707779e-2
1/n^(3/10) = 2.51188643150958e-1
difference = 2.27083676080180e-1
n = 200 , left side = 1.12081526845386e-2
1/n^(3/10) = 2.04028577336837e-1
difference = 1.92820424652298e-1
n = 500 , left side = 4.28703175655956e-3
1/n^(3/10) = 1.54991898754834e-1
difference = 1.50704866998274e-1

```

$$x^4$$

```

n = 10 , left side = 2.71811655321145e-1
1/n^(3/10) = 5.01187233627272e-1
difference = 2.29375578306128e-1
n = 20 , left side = 1.59700780897926e-1
1/n^(3/10) = 4.07090531536904e-1
difference = 2.47389750638979e-1
n = 50 , left side = 4.27867893894553e-2

```

```

1/n^(3/10) = 3.09249494710992e-1
difference = 2.66462705321536e-1
n = 100 , left side = 1.73213915349858e-2
1/n^(3/10) = 2.51188643150958e-1
difference = 2.33867251615972e-1
n = 200 , left side = 7.76000677274190e-3
1/n^(3/10) = 2.04028577336837e-1
difference = 1.96268570564095e-1
n = 500 , left side = 2.90182870840235e-3
1/n^(3/10) = 1.54991898754834e-1
difference = 1.52090070046431e-1

```

$$x^{10}$$

```

n = 10 , left side = 1.86850823331552e-1
1/n^(3/10) = 5.01187233627272e-1
difference = 3.14336410295721e-1
n = 20 , left side = 6.58347789205075e-2
1/n^(3/10) = 4.07090531536904e-1
difference = 3.41255752616397e-1
n = 50 , left side = 4.87085072187460e-3
1/n^(3/10) = 3.09249494710992e-1
difference = 3.04378643989117e-1
n = 100 , left side = 1.09970741430996e-3
1/n^(3/10) = 2.51188643150958e-1
difference = 2.50088935736648e-1
n = 200 , left side = 3.82804893814840e-4
1/n^(3/10) = 2.04028577336837e-1
difference = 2.03645772443022e-1
n = 500 , left side = 1.24276968148319e-4
1/n^(3/10) = 1.54991898754834e-1
difference = 1.54867621786685e-1

```

---

$x_0 = 1/2$ , Power = 3/10, lamda = 1/2, q = 1/2

---


$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 1.96080052578451e-2
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.81579228369427e-1
n = 20 , left side = 2.08299179386357e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.86260613598269e-1
n = 50 , left side = 1.26071386109590e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.96642356100033e-1
n = 100 , left side = 6.81015763376180e-3
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.44378485517196e-1
n = 200 , left side = 3.53432821873068e-3
          1/n^(3/10) = 2.04028577336837e-1
          difference = 2.00494249118106e-1
n = 500 , left side = 1.44549650366432e-3
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.53546402251169e-1

```

$$x$$

```

n = 10 , left side = 5.68097172543790e-2
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.44377516372893e-1
n = 20 , left side = 6.32752819000140e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.43815249636890e-1
n = 50 , left side = 2.77227554082918e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.81526739302700e-1
n = 100 , left side = 1.38629435997858e-2
          1/n^(3/10) = 2.51188643150958e-1

```

```

        difference = 2.37325699551172e-1
n = 200 , left side = 6.93147180559950e-3
        1/n^(3/10) = 2.04028577336837e-1
        difference = 1.97097105531237e-1
n = 500 , left side = 2.77258872223984e-3
        1/n^(3/10) = 1.54991898754834e-1
        difference = 1.52219310032594e-1

```

$$x^2$$

```

n = 10 , left side = 1.47872752410878e-1
        1/n^(3/10) = 5.01187233627272e-1
        difference = 3.53314481216394e-1
n = 20 , left side = 9.78605569036920e-2
        1/n^(3/10) = 4.07090531536904e-1
        difference = 3.09229974633212e-1
n = 50 , left side = 3.38868135786706e-2
        1/n^(3/10) = 3.09249494710992e-1
        difference = 2.75362681132321e-1
n = 100 , left side = 1.54044053860311e-2
        1/n^(3/10) = 2.51188643150958e-1
        difference = 2.35784237764927e-1
n = 200 , left side = 7.31683725369414e-3
        1/n^(3/10) = 2.04028577336837e-1
        difference = 1.96711740083143e-1
n = 500 , left side = 2.83424719393494e-3
        1/n^(3/10) = 1.54991898754834e-1
        difference = 1.52157651560899e-1

```

$$x^3$$

```

n = 10 , left side = 1.73192000431425e-1
        1/n^(3/10) = 5.01187233627272e-1
        difference = 3.27995233195847e-1
n = 20 , left side = 1.03864925521532e-1
        1/n^(3/10) = 4.07090531536904e-1

```

```

        difference = 3.03225606015372e-1
n = 50 , left side = 3.05073733511566e-2
        1/n^(3/10) = 3.09249494710992e-1
        difference = 2.78742121359835e-1
n = 100 , left side = 1.27681795752463e-2
        1/n^(3/10) = 2.51188643150958e-1
        difference = 2.38420463575712e-1
n = 200 , left side = 5.78399942625291e-3
        1/n^(3/10) = 2.04028577336837e-1
        difference = 1.98244577910584e-1
n = 500 , left side = 2.17239948281694e-3
        1/n^(3/10) = 1.54991898754834e-1
        difference = 1.52819499272017e-1

```

$$x^4$$

```

n = 10 , left side = 1.80257354696213e-1
        1/n^(3/10) = 5.01187233627272e-1
        difference = 3.20929878931060e-1
n = 20 , left side = 9.63498090064419e-2
        1/n^(3/10) = 4.07090531536904e-1
        difference = 3.10740722530463e-1
n = 50 , left side = 2.41914336230854e-2
        1/n^(3/10) = 3.09249494710992e-1
        difference = 2.85058061087906e-1
n = 100 , left side = 9.37035404303933e-3
        1/n^(3/10) = 2.51188643150958e-1
        difference = 2.41818289107919e-1
n = 200 , left side = 4.05904957310239e-3
        1/n^(3/10) = 2.04028577336837e-1
        difference = 1.99969527763735e-1
n = 500 , left side = 1.47973714572884e-3
        1/n^(3/10) = 1.54991898754834e-1
        difference = 1.53512161609105e-1

```

$$x^{10}$$

```

n = 10 , left side = 1.19260700953333e-1
          1/n^(3/10) = 5.01187233627272e-1
          difference = 3.81926532673939e-1
n = 20 , left side = 3.73465208237525e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.69744010713152e-1
n = 50 , left side = 2.80162956157203e-3
          1/n^(3/10) = 3.09249494710992e-1
          difference = 3.06447865149420e-1
n = 100 , left side = 6.32905221145960e-4
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.50555737929812e-1
n = 200 , left side = 2.12043953336416e-4
          1/n^(3/10) = 2.04028577336837e-1
          difference = 2.03816533383501e-1
n = 500 , left side = 6.54808182456543e-5
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.54926417936588e-1

```

-----  
x0 = 1/2, Power = 3/10, lamda = 1/2, q = 1  
-----

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 8.10134985303517e-2
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.20173735096921e-1
n = 20 , left side = 1.68560763315222e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.90234455205382e-1
n = 50 , left side = 1.97802106438799e-3
          1/n^(3/10) = 3.09249494710992e-1
          difference = 3.07271473646604e-1
n = 100 , left side = 4.80026592954874e-4

```



```

1/n^(3/10) = 2.51188643150958e-1
difference = 2.50708616558003e-1
n = 200 , left side = 1.19239646471758e-4
1/n^(3/10) = 2.04028577336837e-1
difference = 2.03909337690365e-1
n = 500 , left side = 1.90449720898211e-5
1/n^(3/10) = 1.54991898754834e-1
difference = 1.54972853782744e-1

```

$x$

```

n = 10 , left side = 4.91637605442459e-2
1/n^(3/10) = 5.01187233627272e-1
difference = 4.52023473083026e-1
n = 20 , left side = 3.39394250680031e-3
1/n^(3/10) = 4.07090531536904e-1
difference = 4.03696589030104e-1
n = 50 , left side = 1.64890433873577e-6
1/n^(3/10) = 3.09249494710992e-1
difference = 3.09247845806653e-1
n = 100 , left side = 5.86158899196221e-12
1/n^(3/10) = 2.51188643150958e-1
difference = 2.51188643145096e-1
n = 200 , left side = 0.000000000000000e0
1/n^(3/10) = 2.04028577336837e-1
difference = 2.04028577336837e-1
n = 500 , left side = 0.000000000000000e0
1/n^(3/10) = 1.54991898754834e-1
difference = 1.54991898754834e-1

```

$x^2$

```

n = 10 , left side = 5.25230782287647e-2
1/n^(3/10) = 5.01187233627272e-1
difference = 4.48664155398508e-1
n = 20 , left side = 2.83373415030338e-2

```

```

1/n^(3/10) = 4.07090531536904e-1
difference = 3.78753190033871e-1
n = 50 , left side = 5.39457664221721e-3
1/n^(3/10) = 3.09249494710992e-1
difference = 3.03854918068775e-1
n = 100 , left side = 1.34928057788147e-3
1/n^(3/10) = 2.51188643150958e-1
difference = 2.49839362573077e-1
n = 200 , left side = 3.37320146703068e-4
1/n^(3/10) = 2.04028577336837e-1
difference = 2.03691257190134e-1
n = 500 , left side = 5.39712234723932e-5
1/n^(3/10) = 1.54991898754834e-1
difference = 1.54937927531361e-1

```

$$x^3$$

```

n = 10 , left side = 8.22234506283697e-2
1/n^(3/10) = 5.01187233627272e-1
difference = 4.18963782998903e-1
n = 20 , left side = 4.36057626242193e-2
1/n^(3/10) = 4.07090531536904e-1
difference = 3.63484768912685e-1
n = 50 , left side = 8.09259320656261e-3
1/n^(3/10) = 3.09249494710992e-1
difference = 3.01156901504429e-1
n = 100 , left side = 2.02392086959322e-3
1/n^(3/10) = 2.51188643150958e-1
difference = 2.49164722281365e-1
n = 200 , left side = 5.05980220054464e-4
1/n^(3/10) = 2.04028577336837e-1
difference = 2.03522597116782e-1
n = 500 , left side = 8.09568352086454e-5
1/n^(3/10) = 1.54991898754834e-1
difference = 1.54910941919625e-1

```

$$x^4$$

```

n = 10 , left side = 1.01052973293562e-1
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.00134260333710e-1
n = 20 , left side = 4.67481413489399e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.60342390187965e-1
n = 50 , left side = 8.21282675171929e-3
          1/n^(3/10) = 3.09249494710992e-1
          difference = 3.01036667959272e-1
n = 100 , left side = 2.03145927015683e-3
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.49157183880801e-1
n = 200 , left side = 5.06451370153246e-4
          1/n^(3/10) = 2.04028577336837e-1
          difference = 2.03522125966684e-1
n = 500 , left side = 8.09688966512401e-5
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.54910929858182e-1

```

$$x^{10}$$

```

n = 10 , left side = 7.01207124827066e-2
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.31066521144566e-1
n = 20 , left side = 2.01574704246336e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.86933061112271e-1
n = 50 , left side = 1.42480124701181e-3
          1/n^(3/10) = 3.09249494710992e-1
          difference = 3.07824693463980e-1
n = 100 , left side = 2.63178146244665e-4
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.50925465004713e-1
n = 200 , left side = 6.08599933530729e-5

```

```

1/n^(3/10) = 2.04028577336837e-1
difference = 2.03967717343484e-1
n = 500 , left side = 9.52678517986811e-6
1/n^(3/10) = 1.54991898754834e-1
difference = 1.54982371969654e-1

```

-----  
x0 = 1/2, Power = 3/10, lamda = 1, q = 1/4  
-----

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 5.33369660315086e-2
1/n^(3/10) = 5.01187233627272e-1
difference = 4.47850267595764e-1
n = 20 , left side = 3.23728371506256e-2
1/n^(3/10) = 4.07090531536904e-1
difference = 3.74717694386279e-1
n = 50 , left side = 1.39366391997124e-2
1/n^(3/10) = 3.09249494710992e-1
difference = 2.95312855511279e-1
n = 100 , left side = 7.14621856758935e-3
1/n^(3/10) = 2.51188643150958e-1
difference = 2.44042424583369e-1
n = 200 , left side = 3.61961230894148e-3
1/n^(3/10) = 2.04028577336837e-1
difference = 2.00408965027895e-1
n = 500 , left side = 1.45930076253697e-3
1/n^(3/10) = 1.54991898754834e-1
difference = 1.53532597992297e-1

```

$$x$$

```

n = 10 , left side = 1.29071817455777e-1
1/n^(3/10) = 5.01187233627272e-1

```

```

        difference = 3.72115416171495e-1
n = 20 , left side = 6.92514035886479e-2
        1/n^(3/10) = 4.07090531536904e-1
        difference = 3.37839127948257e-1
n = 50 , left side = 2.77258876437840e-2
        1/n^(3/10) = 3.09249494710992e-1
        difference = 2.81523607067208e-1
n = 100 , left side = 1.38629438314649e-2
        1/n^(3/10) = 2.51188643150958e-1
        difference = 2.37325699319493e-1
n = 200 , left side = 6.93147191573262e-3
        1/n^(3/10) = 2.04028577336837e-1
        difference = 1.97097105421104e-1
n = 500 , left side = 2.77258876629294e-3
        1/n^(3/10) = 1.54991898754834e-1
        difference = 1.52219309988541e-1

```

$$x^2$$

```

n = 10 , left side = 1.77390913518807e-1
        1/n^(3/10) = 5.01187233627272e-1
        difference = 3.23796320108465e-1
n = 20 , left side = 8.30737213816239e-2
        1/n^(3/10) = 4.07090531536904e-1
        difference = 3.24016810155280e-1
n = 50 , left side = 2.99438930027936e-2
        1/n^(3/10) = 3.09249494710992e-1
        difference = 2.79305601708198e-1
n = 100 , left side = 1.44174451738843e-2
        1/n^(3/10) = 2.51188643150958e-1
        difference = 2.36771197977074e-1
n = 200 , left side = 7.07009725133728e-3
        1/n^(3/10) = 2.04028577336837e-1
        difference = 1.96958480085500e-1
n = 500 , left side = 2.79476881998980e-3
        1/n^(3/10) = 1.54991898754834e-1

```

difference = 1.52197129934844e-1

$$x^3$$

n = 10 , left side = 1.81706840017598e-1  
1/n^(3/10) = 5.01187233627272e-1  
difference = 3.19480393609674e-1  
n = 20 , left side = 7.48642399521752e-2  
1/n^(3/10) = 4.07090531536904e-1  
difference = 3.32226291584729e-1  
n = 50 , left side = 2.42632851043291e-2  
1/n^(3/10) = 3.09249494710992e-1  
difference = 2.84986209606663e-1  
n = 100 , left side = 1.12466925545656e-2  
1/n^(3/10) = 2.51188643150958e-1  
difference = 2.39941950596392e-1  
n = 200 , left side = 5.40875852362391e-3  
1/n^(3/10) = 2.04028577336837e-1  
difference = 1.98619818813213e-1  
n = 500 , left side = 2.11285351660356e-3  
1/n^(3/10) = 1.54991898754834e-1  
difference = 1.52879045238230e-1

$$x^4$$

n = 10 , left side = 1.67787178069694e-1  
1/n^(3/10) = 5.01187233627272e-1  
difference = 3.33400055557578e-1  
n = 20 , left side = 6.03397370785074e-2  
1/n^(3/10) = 4.07090531536904e-1  
difference = 3.46750794458397e-1  
n = 50 , left side = 1.74893080184918e-2  
1/n^(3/10) = 3.09249494710992e-1  
difference = 2.91760186692500e-1  
n = 100 , left side = 7.79966635748684e-3  
1/n^(3/10) = 2.51188643150958e-1

```

        difference = 2.43388976793471e-1
n = 200 , left side = 3.67816819644862e-3
        1/n^(3/10) = 2.04028577336837e-1
        difference = 2.00350409140388e-1
n = 500 , left side = 1.41984974971862e-3
        1/n^(3/10) = 1.54991898754834e-1
        difference = 1.53572049005115e-1

```

$$x^{10}$$

```

n = 10 , left side = 7.68027797084297e-2
        1/n^(3/10) = 5.01187233627272e-1
        difference = 4.24384453918843e-1
n = 20 , left side = 9.76146773173455e-3
        1/n^(3/10) = 4.07090531536904e-1
        difference = 3.97329063805170e-1
n = 50 , left side = 1.13068528957833e-3
        1/n^(3/10) = 3.09249494710992e-1
        difference = 3.08118809421413e-1
n = 100 , left side = 3.88474877995740e-4
        1/n^(3/10) = 2.51188643150958e-1
        difference = 2.50800168272962e-1
n = 200 , left side = 1.62038602245949e-4
        1/n^(3/10) = 2.04028577336837e-1
        difference = 2.03866538734591e-1
n = 500 , left side = 5.81892063838071e-5
        1/n^(3/10) = 1.54991898754834e-1
        difference = 1.54933709548450e-1

```

-----  
x0 = 1/2, Power = 3/10, lamda = 1, q = 1/2  
-----

$$x^{\frac{1}{3}}$$

$n = 10$  , left side =  $1.96445247579275e-2$   
 $1/n^{(3/10)} = 5.01187233627272e-1$   
difference =  $4.81542708869345e-1$   
 $n = 20$  , left side =  $1.48888789279410e-2$   
 $1/n^{(3/10)} = 4.07090531536904e-1$   
difference =  $3.92201652608963e-1$   
 $n = 50$  , left side =  $6.77605354912036e-3$   
 $1/n^{(3/10)} = 3.09249494710992e-1$   
difference =  $3.02473441161871e-1$   
 $n = 100$  , left side =  $3.52568356510696e-3$   
 $1/n^{(3/10)} = 2.51188643150958e-1$   
difference =  $2.47662959585851e-1$   
 $n = 200$  , left side =  $1.79801315131478e-3$   
 $1/n^{(3/10)} = 2.04028577336837e-1$   
difference =  $2.02230564185522e-1$   
 $n = 500$  , left side =  $7.27768804896778e-4$   
 $1/n^{(3/10)} = 1.54991898754834e-1$   
difference =  $1.54264129949937e-1$

*x*

$n = 10$  , left side =  $6.38935662496243e-2$   
 $1/n^{(3/10)} = 5.01187233627272e-1$   
difference =  $4.37293667377648e-1$   
 $n = 20$  , left side =  $3.46235470985200e-2$   
 $1/n^{(3/10)} = 4.07090531536904e-1$   
difference =  $3.72466984438384e-1$   
 $n = 50$  , left side =  $1.38629429714340e-2$   
 $1/n^{(3/10)} = 3.09249494710992e-1$   
difference =  $2.95386551739558e-1$   
 $n = 100$  , left side =  $6.93147149063511e-3$   
 $1/n^{(3/10)} = 2.51188643150958e-1$   
difference =  $2.44257171660323e-1$   
 $n = 200$  , left side =  $3.46573574531761e-3$   
 $1/n^{(3/10)} = 2.04028577336837e-1$   
difference =  $2.00562841591519e-1$



n = 500 , left side = 1.38629429812698e-3  
 1/n^(3/10) = 1.54991898754834e-1  
 difference = 1.53605604456707e-1

$$x^2$$

n = 10 , left side = 1.01231195168683e-1  
 1/n^(3/10) = 5.01187233627272e-1  
 difference = 3.99956038458589e-1  
 n = 20 , left side = 4.48623512045706e-2  
 1/n^(3/10) = 4.07090531536904e-1  
 difference = 3.62228180332334e-1  
 n = 50 , left side = 1.55044047114583e-2  
 1/n^(3/10) = 3.09249494710992e-1  
 difference = 2.93745089999533e-1  
 n = 100 , left side = 7.34183692697721e-3  
 1/n^(3/10) = 2.51188643150958e-1  
 difference = 2.43846806223981e-1  
 n = 200 , left side = 3.56832710440330e-3  
 1/n^(3/10) = 2.04028577336837e-1  
 difference = 2.00460250232434e-1  
 n = 500 , left side = 1.40270891558064e-3  
 1/n^(3/10) = 1.54991898754834e-1  
 difference = 1.53589189839253e-1

$$x^3$$

n = 10 , left side = 1.09051180141690e-1  
 1/n^(3/10) = 5.01187233627272e-1  
 difference = 3.92136053485583e-1  
 n = 20 , left side = 4.22970110547810e-2  
 1/n^(3/10) = 4.07090531536904e-1  
 difference = 3.64793520482123e-1  
 n = 50 , left side = 1.29223379237350e-2  
 1/n^(3/10) = 3.09249494710992e-1  
 difference = 2.96327156787257e-1

$n = 100$  , left side = 5.82201903348858e-3  
 $1/n^{(3/10)} = 2.51188643150958e-1$   
difference = 2.45366624117469e-1  
 $n = 200$  , left side = 2.75417225524133e-3  
 $1/n^{(3/10)} = 2.04028577336837e-1$   
difference = 2.01274405081596e-1  
 $n = 500$  , left side = 1.06440558786375e-3  
 $1/n^{(3/10)} = 1.54991898754834e-1$   
difference = 1.53927493166970e-1

$$x^4$$

$n = 10$  , left side = 1.02540884681400e-1  
 $1/n^{(3/10)} = 5.01187233627272e-1$   
difference = 3.98646348945873e-1  
 $n = 20$  , left side = 3.49981874860215e-2  
 $1/n^{(3/10)} = 4.07090531536904e-1$   
difference = 3.72092344050883e-1  
 $n = 50$  , left side = 9.52960631552963e-3  
 $1/n^{(3/10)} = 3.09249494710992e-1$   
difference = 2.99719888395462e-1  
 $n = 100$  , left side = 4.09764755001933e-3  
 $1/n^{(3/10)} = 2.51188643150958e-1$   
difference = 2.47090995600939e-1  
 $n = 200$  , left side = 1.88876104704867e-3  
 $1/n^{(3/10)} = 2.04028577336837e-1$   
difference = 2.02139816289788e-1  
 $n = 500$  , left side = 7.17895958025169e-4  
 $1/n^{(3/10)} = 1.54991898754834e-1$   
difference = 1.54274002796809e-1

$$x^{10}$$

$n = 10$  , left side = 4.39432749437959e-2  
 $1/n^{(3/10)} = 5.01187233627272e-1$   
difference = 4.57243958683477e-1

```

n = 20 , left side = 5.59881198565935e-3
          1/n^(3/10) = 4.07090531536904e-1
          difference = 4.01491719551245e-1
n = 50 , left side = 6.58122885628412e-4
          1/n^(3/10) = 3.09249494710992e-1
          difference = 3.08591371825363e-1
n = 100 , left side = 2.17135216419487e-4
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.50971507934539e-1
n = 200 , left side = 8.67799400498142e-5
          1/n^(3/10) = 2.04028577336837e-1
          difference = 2.03941797396787e-1
n = 500 , left side = 3.00238003037257e-5
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.54961874954530e-1

```

-----  
x0 = 1/2, Power = 3/10, lamda = 1, q = 1  
-----

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 1.88583358245117e-2
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.82328897802761e-1
n = 20 , left side = 3.43036193768773e-3
          1/n^(3/10) = 4.07090531536904e-1
          difference = 4.03660169599217e-1
n = 50 , left side = 5.15745217625430e-4
          1/n^(3/10) = 3.09249494710992e-1
          difference = 3.08733749493366e-1
n = 100 , left side = 1.28085535782918e-4
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.51060557615175e-1
n = 200 , left side = 3.19697272260777e-5

```

```

1/n^(3/10) = 2.04028577336837e-1
difference = 2.03996607609611e-1
n = 500 , left side = 5.11285838611375e-6
1/n^(3/10) = 1.54991898754834e-1
difference = 1.54986785896448e-1

```

$x$

```

n = 10 , left side = 3.03097878388942e-3
1/n^(3/10) = 5.01187233627272e-1
difference = 4.98156254843383e-1
n = 20 , left side = 1.79813965208164e-5
1/n^(3/10) = 4.07090531536904e-1
difference = 4.07072550140384e-1
n = 50 , left side = 5.04973840520506e-12
1/n^(3/10) = 3.09249494710992e-1
difference = 3.09249494705942e-1
n = 100 , left side = 0.000000000000000e0
1/n^(3/10) = 2.51188643150958e-1
difference = 2.51188643150958e-1
n = 200 , left side = 0.000000000000000e0
1/n^(3/10) = 2.04028577336837e-1
difference = 2.04028577336837e-1
n = 500 , left side = 0.000000000000000e0
1/n^(3/10) = 1.54991898754834e-1
difference = 1.54991898754834e-1

```

$x^2$

```

n = 10 , left side = 3.13288100022529e-2
1/n^(3/10) = 5.01187233627272e-1
difference = 4.69858423625019e-1
n = 20 , left side = 9.02981956494564e-3
1/n^(3/10) = 4.07090531536904e-1
difference = 3.98060711971959e-1
n = 50 , left side = 1.44928066358063e-3

```

```

1/n^(3/10) = 3.09249494710992e-1
difference = 3.07800214047411e-1
n = 100 , left side = 3.62320167826058e-4
1/n^(3/10) = 2.51188643150958e-1
difference = 2.50826322983132e-1
n = 200 , left side = 9.05800419564451e-5
1/n^(3/10) = 2.04028577336837e-1
difference = 2.03937997294881e-1
n = 500 , left side = 1.44928067127847e-5
1/n^(3/10) = 1.54991898754834e-1
difference = 1.54977405948121e-1

```

$$x^3$$

```

n = 10 , left side = 4.78600213916087e-2
1/n^(3/10) = 5.01187233627272e-1
difference = 4.53327212235664e-1
n = 20 , left side = 1.35520533206202e-2
1/n^(3/10) = 4.07090531536904e-1
difference = 3.93538478216284e-1
n = 50 , left side = 2.17392099772526e-3
1/n^(3/10) = 3.09249494710992e-1
difference = 3.07075573713266e-1
n = 100 , left side = 5.43480251739198e-4
1/n^(3/10) = 2.51188643150958e-1
difference = 2.50645162899219e-1
n = 200 , left side = 1.35870062934806e-4
1/n^(3/10) = 2.04028577336837e-1
difference = 2.03892707273902e-1
n = 500 , left side = 2.17392100697045e-5
1/n^(3/10) = 1.54991898754834e-1
difference = 1.54970159544764e-1

```

$$x^4$$

```

n = 10 , left side = 5.14533906505906e-2

```

```

1/n^(3/10) = 5.01187233627272e-1
difference = 4.49733842976682e-1
n = 20 , left side = 1.38732244570935e-2
1/n^(3/10) = 4.07090531536904e-1
difference = 3.93217307079811e-1
n = 50 , left side = 2.18227896612333e-3
1/n^(3/10) = 3.09249494710992e-1
difference = 3.07067215744868e-1
n = 100 , left side = 5.44002624822598e-4
1/n^(3/10) = 2.51188643150958e-1
difference = 2.50644640526135e-1
n = 200 , left side = 1.35902711252578e-4
1/n^(3/10) = 2.04028577336837e-1
difference = 2.03892674625584e-1
n = 500 , left side = 2.17400458665112e-5
1/n^(3/10) = 1.54991898754834e-1
difference = 1.54970158708967e-1

```

$$x^{10}$$

```

n = 10 , left side = 2.39574413183784e-2
1/n^(3/10) = 5.01187233627272e-1
difference = 4.77229792308894e-1
n = 20 , left side = 2.97086004062650e-3
1/n^(3/10) = 4.07090531536904e-1
difference = 4.04119671496278e-1
n = 50 , left side = 2.83599622557920e-4
1/n^(3/10) = 3.09249494710992e-1
difference = 3.08965895088434e-1
n = 100 , left side = 6.54249762593842e-5
1/n^(3/10) = 2.51188643150958e-1
difference = 2.51123218174699e-1
n = 200 , left side = 1.60297404173209e-5
1/n^(3/10) = 2.04028577336837e-1
difference = 2.04012547596420e-1
n = 500 , left side = 2.55030753033912e-6

```

$1/n^{(3/10)} = 1.54991898754834e-1$   
 $\text{difference} = 1.54989348447303e-1$

-----  
 $x_0 = 1/2, \text{Power} = 1/2, \text{lamda} = 1/4, \quad q = 1/4$   
 -----

$$x^{\frac{1}{3}}$$

$n = 10$  , left side =  $7.33574282376017e-2$   
 $1/n^{(1/2)} = 3.16227766016838e-1$   
 $\text{difference} = 2.42870337779236e-1$   
 $n = 20$  , left side =  $4.53841801182795e-2$   
 $1/n^{(1/2)} = 2.23606797749979e-1$   
 $\text{difference} = 1.78222617631699e-1$   
 $n = 50$  , left side =  $4.74957712877522e-2$   
 $1/n^{(1/2)} = 1.41421356237310e-1$   
 $\text{difference} = 9.39255849495573e-2$   
 $n = 100$  , left side =  $2.67013950556243e-2$   
 $1/n^{(1/2)} = 1.00000000000000e-1$   
 $\text{difference} = 7.32986049443757e-2$   
 $n = 200$  , left side =  $1.39773905392242e-2$   
 $1/n^{(1/2)} = 7.07106781186548e-2$   
 $\text{difference} = 5.67332875794306e-2$   
 $n = 500$  , left side =  $5.75326859927561e-3$   
 $1/n^{(1/2)} = 4.47213595499958e-2$   
 $\text{difference} = 3.89680909507202e-2$

$$x$$

$n = 10$  , left side =  $1.48505389324612e-2$   
 $1/n^{(1/2)} = 3.16227766016838e-1$   
 $\text{difference} = 3.01377227084377e-1$   
 $n = 20$  , left side =  $1.39174879467004e-1$   
 $1/n^{(1/2)} = 2.23606797749979e-1$

```

        difference = 8.44319182829745e-2
n = 50 , left side = 1.07608816899145e-1
        1/n^(1/2) = 1.41421356237310e-1
        difference = 3.38125393381641e-2
n = 100 , left side = 5.54452812788874e-2
        1/n^(1/2) = 1.00000000000000e-1
        difference = 4.45547187211126e-2
n = 200 , left side = 2.77258871979472e-2
        1/n^(1/2) = 7.07106781186548e-2
        difference = 4.29847909207075e-2
n = 500 , left side = 1.10903548889592e-2
        1/n^(1/2) = 4.47213595499958e-2
        difference = 3.36310046610366e-2

```

$$x^2$$

```

n = 10 , left side = 1.94005188391137e-1
        1/n^(1/2) = 3.16227766016838e-1
        difference = 1.22222577625701e-1
n = 20 , left side = 2.30868040947246e-1
        1/n^(1/2) = 2.23606797749979e-1
        difference = -7.26124319726737e-3
n = 50 , left side = 1.38886956653740e-1
        1/n^(1/2) = 1.41421356237310e-1
        difference = 2.53439958356949e-3
n = 100 , left side = 6.38134518553904e-2
        1/n^(1/2) = 1.00000000000000e-1
        difference = 3.61865481446096e-2
n = 200 , left side = 2.98188925936178e-2
        1/n^(1/2) = 7.07106781186548e-2
        difference = 4.08917855250369e-2
n = 500 , left side = 1.14252357544120e-2
        1/n^(1/2) = 4.47213595499958e-2
        difference = 3.32961237955838e-2

```

$$x^3$$



```

n = 10 , left side = 2.06175421900515e-1
          1/n^(1/2) = 3.16227766016838e-1
          difference = 1.10052344116323e-1
n = 20 , left side = 2.53575282932135e-1
          1/n^(1/2) = 2.23606797749979e-1
          difference = -2.99684851821556e-2
n = 50 , left side = 1.34595194359457e-1
          1/n^(1/2) = 1.41421356237310e-1
          difference = 6.82616187785257e-3
n = 100 , left side = 5.51857590364190e-2
          1/n^(1/2) = 1.00000000000000e-1
          difference = 4.48142409635810e-2
n = 200 , left side = 2.40653876252187e-2
          1/n^(1/2) = 7.07106781186548e-2
          difference = 4.66452904934360e-2
n = 500 , left side = 8.82850116987996e-3
          1/n^(1/2) = 4.47213595499958e-2
          difference = 3.58928583801158e-2

```

$$x^4$$

```

n = 10 , left side = 2.45980444406422e-1
          1/n^(1/2) = 3.16227766016838e-1
          difference = 7.02473216104160e-2
n = 20 , left side = 2.51901006172595e-1
          1/n^(1/2) = 2.23606797749979e-1
          difference = -2.82942084226162e-2
n = 50 , left side = 1.17335729825915e-1
          1/n^(1/2) = 1.41421356237310e-1
          difference = 2.40856264113941e-2
n = 100 , left side = 4.25973806719297e-2
          1/n^(1/2) = 1.00000000000000e-1
          difference = 5.74026193280703e-2
n = 200 , left side = 1.72794180717638e-2
          1/n^(1/2) = 7.07106781186548e-2
          difference = 5.34312600468910e-2

```

```

n = 500 , left side = 6.06468552840353e-3
          1/n^(1/2) = 4.47213595499958e-2
          difference = 3.86566740215923e-2

```

$$x^{10}$$

```

n = 10 , left side = 1.88296929722229e-1
          1/n^(1/2) = 3.16227766016838e-1
          difference = 1.27930836294609e-1
n = 20 , left side = 1.57124987034018e-1
          1/n^(1/2) = 2.23606797749979e-1
          difference = 6.64818107159607e-2
n = 50 , left side = 3.56919049916328e-2
          1/n^(1/2) = 1.41421356237310e-1
          difference = 1.05729451245677e-1
n = 100 , left side = 4.80555765395147e-3
          1/n^(1/2) = 1.00000000000000e-1
          difference = 9.51944423460485e-2
n = 200 , left side = 1.09199033498743e-3
          1/n^(1/2) = 7.07106781186548e-2
          difference = 6.96186877836673e-2
n = 500 , left side = 2.84658201772995e-4
          1/n^(1/2) = 4.47213595499958e-2
          difference = 4.44367013482228e-2

```

-----  
x0 = 1/2, Power = 1/2, lamda = 1/4, q = 1/2  
-----

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 1.26504552641874e-1
          1/n^(1/2) = 3.16227766016838e-1
          difference = 1.89723213374964e-1
n = 20 , left side = 2.03548587742321e-2

```

```

1/n^(1/2) = 2.23606797749979e-1
difference = 2.03251938975747e-1
n = 50 , left side = 2.03304570248800e-2
1/n^(1/2) = 1.41421356237310e-1
difference = 1.21090899212429e-1
n = 100 , left side = 1.26409079150098e-2
1/n^(1/2) = 1.00000000000000e-1
difference = 8.73590920849902e-2
n = 200 , left side = 6.81868079261294e-3
1/n^(1/2) = 7.07106781186548e-2
difference = 6.38919973260418e-2
n = 500 , left side = 2.84988268112463e-3
1/n^(1/2) = 4.47213595499958e-2
difference = 4.18714768688712e-2

```

*x*

```

n = 10 , left side = 8.02267409115550e-2
1/n^(1/2) = 3.16227766016838e-1
difference = 2.36001025105283e-1
n = 20 , left side = 5.14929405767165e-2
1/n^(1/2) = 2.23606797749979e-1
difference = 1.72113857173262e-1
n = 50 , left side = 5.36143926388598e-2
1/n^(1/2) = 1.41421356237310e-1
difference = 8.78069635984497e-2
n = 100 , left side = 2.77224568458393e-2
1/n^(1/2) = 1.00000000000000e-1
difference = 7.22775431541607e-2
n = 200 , left side = 1.38629435986308e-2
1/n^(1/2) = 7.07106781186548e-2
difference = 5.68477345200239e-2
n = 500 , left side = 5.54517744447935e-3
1/n^(1/2) = 4.47213595499958e-2
difference = 3.91761821055164e-2

```

$$x^2$$

```

n = 10 , left side = 1.28296366461717e-1
          1/n^(1/2) = 3.16227766016838e-1
          difference = 1.87931399555121e-1
n = 20 , left side = 1.38397942935223e-1
          1/n^(1/2) = 2.23606797749979e-1
          difference = 8.52088548147560e-2
n = 50 , left side = 7.67416652503929e-2
          1/n^(1/2) = 1.41421356237310e-1
          difference = 6.46796909869166e-2
n = 100 , left side = 3.37863631986791e-2
          1/n^(1/2) = 1.00000000000000e-1
          difference = 6.62136368013209e-2
n = 200 , left side = 1.53794053842907e-2
          1/n^(1/2) = 7.07106781186548e-2
          difference = 5.53312727343640e-2
n = 500 , left side = 5.78781133126016e-3
          1/n^(1/2) = 4.47213595499958e-2
          difference = 3.89335482187356e-2

```

$$x^3$$

```

n = 10 , left side = 1.27831704419723e-1
          1/n^(1/2) = 3.16227766016838e-1
          difference = 1.88396061597115e-1
n = 20 , left side = 1.61344011208260e-1
          1/n^(1/2) = 2.23606797749979e-1
          difference = 6.22627865417192e-2
n = 50 , left side = 7.78602100423141e-2
          1/n^(1/2) = 1.41421356237310e-1
          difference = 6.35611461949954e-2
n = 100 , left side = 3.03485286276982e-2
          1/n^(1/2) = 1.00000000000000e-1
          difference = 6.96514713723018e-2
n = 200 , left side = 1.27296398524397e-2

```

```

1/n^(1/2) = 7.07106781186548e-2
difference = 5.79810382662150e-2
n = 500 , left side = 4.52652924015576e-3
1/n^(1/2) = 4.47213595499958e-2
difference = 4.01948303098400e-2

```

$$x^4$$

```

n = 10 , left side = 1.84494512877635e-1
1/n^(1/2) = 3.16227766016838e-1
difference = 1.31733253139203e-1
n = 20 , left side = 1.66506805511951e-1
1/n^(1/2) = 2.23606797749979e-1
difference = 5.70999922380279e-2
n = 50 , left side = 6.92290642748952e-2
1/n^(1/2) = 1.41421356237310e-1
difference = 7.21922919624143e-2
n = 100 , left side = 2.40205845419831e-2
1/n^(1/2) = 1.00000000000000e-1
difference = 7.59794154580169e-2
n = 200 , left side = 9.33054650504601e-3
1/n^(1/2) = 7.07106781186548e-2
difference = 6.13801316136087e-2
n = 500 , left side = 3.14415812448704e-3
1/n^(1/2) = 4.47213595499958e-2
difference = 4.15772014255088e-2

```

$$x^{10}$$

```

n = 10 , left side = 1.40771586828727e-1
1/n^(1/2) = 3.16227766016838e-1
difference = 1.75456179188111e-1
n = 20 , left side = 1.00214745282116e-1
1/n^(1/2) = 2.23606797749979e-1
difference = 1.23392052467863e-1
n = 50 , left side = 1.99853845577975e-2

```

```

1/n^(1/2) = 1.41421356237310e-1
difference = 1.21435971679512e-1
n = 100 , left side = 2.75646208624215e-3
1/n^(1/2) = 1.00000000000000e-1
difference = 9.72435379137579e-2
n = 200 , left side = 6.26624240120877e-4
1/n^(1/2) = 7.07106781186548e-2
difference = 7.00840538785339e-2
n = 500 , left side = 1.55217235579062e-4
1/n^(1/2) = 4.47213595499958e-2
difference = 4.45661423144167e-2

```

-----  
x0 = 1/2, Power = 1/2, lamda = 1/4, q = 1  
-----

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 2.09749541545875e-1
1/n^(1/2) = 3.16227766016838e-1
difference = 1.06478224470963e-1
n = 20 , left side = 7.85812770396360e-2
1/n^(1/2) = 2.23606797749979e-1
difference = 1.45025520710343e-1
n = 50 , left side = 9.34393044496805e-3
1/n^(1/2) = 1.41421356237310e-1
difference = 1.32077425792341e-1
n = 100 , left side = 1.94070471300620e-3
1/n^(1/2) = 1.00000000000000e-1
difference = 9.80592952869938e-2
n = 200 , left side = 4.71100029514671e-4
1/n^(1/2) = 7.07106781186548e-2
difference = 7.02395780891401e-2
n = 500 , left side = 7.48422627483425e-5
1/n^(1/2) = 4.47213595499958e-2

```

difference = 4.46465172872475e-2

$x$

n = 10 , left side = 2.08951638220122e-1  
1/n^(1/2) = 3.16227766016838e-1  
difference = 1.07276127796716e-1  
n = 20 , left side = 5.25889244914822e-2  
1/n^(1/2) = 2.23606797749979e-1  
difference = 1.71017873258497e-1  
n = 50 , left side = 1.01379455384021e-3  
1/n^(1/2) = 1.41421356237310e-1  
difference = 1.40407561683469e-1  
n = 100 , left side = 1.80708522862227e-6  
1/n^(1/2) = 1.00000000000000e-1  
difference = 9.99981929147714e-2  
n = 200 , left side = 6.45467013171697e-12  
1/n^(1/2) = 7.07106781186548e-2  
difference = 7.07106781122001e-2  
n = 500 , left side = 0.00000000000000e0  
1/n^(1/2) = 4.47213595499958e-2  
difference = 4.47213595499958e-2

$x^2$

n = 10 , left side = 6.09251809834974e-2  
1/n^(1/2) = 3.16227766016838e-1  
difference = 2.55302585033341e-1  
n = 20 , left side = 4.57428235934711e-2  
1/n^(1/2) = 2.23606797749979e-1  
difference = 1.77863974156508e-1  
n = 50 , left side = 1.96014797649490e-2  
1/n^(1/2) = 1.41421356237310e-1  
difference = 1.21819876472361e-1  
n = 100 , left side = 5.29434230595233e-3  
1/n^(1/2) = 1.00000000000000e-1

```

difference = 9.47056576940477e-2
n = 200 , left side = 1.32428057699463e-3
1/n^(1/2) = 7.07106781186548e-2
difference = 6.93863975416601e-2
n = 500 , left side = 2.11884893889736e-4
1/n^(1/2) = 4.47213595499958e-2
difference = 4.45094746561061e-2

```

$$x^3$$

```

n = 10 , left side = 3.81659578000774e-2
1/n^(1/2) = 3.16227766016838e-1
difference = 2.78061808216761e-1
n = 20 , left side = 7.43081431790645e-2
1/n^(1/2) = 2.23606797749979e-1
difference = 1.49298654570914e-1
n = 50 , left side = 2.97879650699726e-2
1/n^(1/2) = 1.41421356237310e-1
difference = 1.11633391167337e-1
n = 100 , left side = 7.94232255998317e-3
1/n^(1/2) = 1.00000000000000e-1
difference = 9.20576774400168e-2
n = 200 , left side = 1.98642086856246e-3
1/n^(1/2) = 7.07106781186548e-2
difference = 6.87242572500923e-2
n = 500 , left side = 3.17827340834853e-4
1/n^(1/2) = 4.47213595499958e-2
difference = 4.44035322091609e-2

```

$$x^4$$

```

n = 10 , left side = 1.25757444757586e-1
1/n^(1/2) = 3.16227766016838e-1
difference = 1.90470321259252e-1
n = 20 , left side = 9.19703672747021e-2
1/n^(1/2) = 2.23606797749979e-1

```



```

        difference = 1.31636430475277e-1
n = 50 , left side = 3.13124123712135e-2
        1/n^(1/2) = 1.41421356237310e-1
        difference = 1.10108943866096e-1
n = 100 , left side = 8.05935138518928e-3
        1/n^(1/2) = 1.00000000000000e-1
        difference = 9.19406486148107e-2
n = 200 , left side = 1.99376000196878e-3
        1/n^(1/2) = 7.07106781186548e-2
        difference = 6.87169181166860e-2
n = 500 , left side = 3.18015222677798e-4
        1/n^(1/2) = 4.47213595499958e-2
        difference = 4.44033443273180e-2

```

$$x^{10}$$

```

n = 10 , left side = 9.92211518367574e-2
        1/n^(1/2) = 3.16227766016838e-1
        difference = 2.17006614180081e-1
n = 20 , left side = 5.87860822296067e-2
        1/n^(1/2) = 2.23606797749979e-1
        difference = 1.64820715520372e-1
n = 50 , left side = 1.06402237950819e-2
        1/n^(1/2) = 1.41421356237310e-1
        difference = 1.30781132442228e-1
n = 100 , left side = 1.39397823915505e-3
        1/n^(1/2) = 1.00000000000000e-1
        difference = 9.86060217608450e-2
n = 200 , left side = 2.58092754851807e-4
        1/n^(1/2) = 7.07106781186548e-2
        difference = 7.04525853638029e-2
n = 500 , left side = 3.78668260722235e-5
        1/n^(1/2) = 4.47213595499958e-2
        difference = 4.46834927239236e-2

```

-----  
x0 = 1/2, Power = 1/2, lamda = 1/2, q = 1/4  
-----

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 4.65939350634126e-2
          1/n^(1/2) = 3.16227766016838e-1
          difference = 2.69633830953425e-1
n = 20 , left side = 5.39175273339060e-2
          1/n^(1/2) = 2.23606797749979e-1
          difference = 1.69689270416073e-1
n = 50 , left side = 2.66706958509519e-2
          1/n^(1/2) = 1.41421356237310e-1
          difference = 1.14750660386358e-1
n = 100 , left side = 1.39692422376499e-2
          1/n^(1/2) = 1.00000000000000e-1
          difference = 8.60307577623501e-2
n = 200 , left side = 7.15466879542803e-3
          1/n^(1/2) = 7.07106781186548e-2
          difference = 6.35560093232267e-2
n = 500 , left side = 2.90466167844949e-3
          1/n^(1/2) = 4.47213595499958e-2
          difference = 4.18166978715463e-2

```

$$x$$

```

n = 10 , left side = 1.46960541508878e-1
          1/n^(1/2) = 3.16227766016838e-1
          difference = 1.69267224507960e-1
n = 20 , left side = 1.28044818944893e-1
          1/n^(1/2) = 2.23606797749979e-1
          difference = 9.55619788050857e-2
n = 50 , left side = 5.54458428059441e-2
          1/n^(1/2) = 1.41421356237310e-1
          difference = 8.59755134313654e-2

```

n = 100 , left side = 2.77258872001895e-2  
           1/n^(1/2) = 1.00000000000000e-1  
           difference = 7.22741127998105e-2  
 n = 200 , left side = 1.38629436111990e-2  
           1/n^(1/2) = 7.07106781186548e-2  
           difference = 5.68477345074558e-2  
 n = 500 , left side = 5.54517744447969e-3  
           1/n^(1/2) = 4.47213595499958e-2  
           difference = 3.91761821055161e-2

$$x^2$$

n = 10 , left side = 2.44068957215094e-1  
           1/n^(1/2) = 3.16227766016838e-1  
           difference = 7.21588088017442e-2  
 n = 20 , left side = 1.73393496362237e-1  
           1/n^(1/2) = 2.23606797749979e-1  
           difference = 5.02133013877419e-2  
 n = 50 , left side = 6.39143140576404e-2  
           1/n^(1/2) = 1.41421356237310e-1  
           difference = 7.75070421796691e-2  
 n = 100 , left side = 2.98438925970290e-2  
           1/n^(1/2) = 1.00000000000000e-1  
           difference = 7.01561074029710e-2  
 n = 200 , left side = 1.43924449634690e-2  
           1/n^(1/2) = 7.07106781186548e-2  
           difference = 5.63182331551857e-2  
 n = 500 , left side = 5.62989766084282e-3  
           1/n^(1/2) = 4.47213595499958e-2  
           difference = 3.90914618891530e-2

$$x^3$$

n = 10 , left side = 2.70532081486956e-1  
           1/n^(1/2) = 3.16227766016838e-1  
           difference = 4.56956845298820e-2

$n = 20$  , left side = 1.75303858260733e-1  
 $1/n^{(1/2)} = 2.23606797749979e-1$   
difference = 4.83029394892462e-2  
 $n = 50$  , left side = 5.53534166881952e-2  
 $1/n^{(1/2)} = 1.41421356237310e-1$   
difference = 8.60679395491143e-2  
 $n = 100$  , left side = 2.41049670707779e-2  
 $1/n^{(1/2)} = 1.00000000000000e-1$   
difference = 7.58950329292221e-2  
 $n = 200$  , left side = 1.12081526845386e-2  
 $1/n^{(1/2)} = 7.07106781186548e-2$   
difference = 5.95025254341161e-2  
 $n = 500$  , left side = 4.28703175655956e-3  
 $1/n^{(1/2)} = 4.47213595499958e-2$   
difference = 4.04343277934362e-2

$$x^4$$

$n = 10$  , left side = 2.71811655321145e-1  
 $1/n^{(1/2)} = 3.16227766016838e-1$   
difference = 4.44161106956934e-2  
 $n = 20$  , left side = 1.59700780897926e-1  
 $1/n^{(1/2)} = 2.23606797749979e-1$   
difference = 6.39060168520533e-2  
 $n = 50$  , left side = 4.27867893894553e-2  
 $1/n^{(1/2)} = 1.41421356237310e-1$   
difference = 9.86345668478542e-2  
 $n = 100$  , left side = 1.73213915349858e-2  
 $1/n^{(1/2)} = 1.00000000000000e-1$   
difference = 8.26786084650142e-2  
 $n = 200$  , left side = 7.76000677274190e-3  
 $1/n^{(1/2)} = 7.07106781186548e-2$   
difference = 6.29506713459129e-2  
 $n = 500$  , left side = 2.90182870840235e-3  
 $1/n^{(1/2)} = 4.47213595499958e-2$   
difference = 4.18195308415934e-2

$$x^{10}$$

```

n = 10 , left side = 1.86850823331552e-1
          1/n^(1/2) = 3.16227766016838e-1
          difference = 1.29376942685286e-1
n = 20 , left side = 6.58347789205075e-2
          1/n^(1/2) = 2.23606797749979e-1
          difference = 1.57772018829471e-1
n = 50 , left side = 4.87085072187460e-3
          1/n^(1/2) = 1.41421356237310e-1
          difference = 1.36550505515435e-1
n = 100 , left side = 1.09970741430996e-3
          1/n^(1/2) = 1.00000000000000e-1
          difference = 9.89002925856901e-2
n = 200 , left side = 3.82804893814840e-4
          1/n^(1/2) = 7.07106781186548e-2
          difference = 7.03278732248399e-2
n = 500 , left side = 1.24276968148319e-4
          1/n^(1/2) = 4.47213595499958e-2
          difference = 4.45970825818475e-2

```

-----  
x0 = 1/2, Power = 1/2, lamda = 1/2, q = 1/2  
-----

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 1.96080052578451e-2
          1/n^(1/2) = 3.16227766016838e-1
          difference = 2.96619760758993e-1
n = 20 , left side = 2.08299179386357e-2
          1/n^(1/2) = 2.23606797749979e-1
          difference = 2.02776879811343e-1
n = 50 , left side = 1.26071386109590e-2
          1/n^(1/2) = 1.41421356237310e-1

```

```

        difference = 1.28814217626351e-1
n = 100 , left side = 6.81015763376180e-3
        1/n^(1/2) = 1.00000000000000e-1
        difference = 9.31898423662382e-2
n = 200 , left side = 3.53432821873068e-3
        1/n^(1/2) = 7.07106781186548e-2
        difference = 6.71763498999241e-2
n = 500 , left side = 1.44549650366432e-3
        1/n^(1/2) = 4.47213595499958e-2
        difference = 4.32758630463315e-2

```

$x$

```

n = 10 , left side = 5.68097172543790e-2
        1/n^(1/2) = 3.16227766016838e-1
        difference = 2.59418048762459e-1
n = 20 , left side = 6.32752819000140e-2
        1/n^(1/2) = 2.23606797749979e-1
        difference = 1.60331515849965e-1
n = 50 , left side = 2.77227554082918e-2
        1/n^(1/2) = 1.41421356237310e-1
        difference = 1.13698600829018e-1
n = 100 , left side = 1.38629435997858e-2
        1/n^(1/2) = 1.00000000000000e-1
        difference = 8.61370564002142e-2
n = 200 , left side = 6.93147180559950e-3
        1/n^(1/2) = 7.07106781186548e-2
        difference = 6.37792063130553e-2
n = 500 , left side = 2.77258872223984e-3
        1/n^(1/2) = 4.47213595499958e-2
        difference = 4.19487708277560e-2

```

$x^2$

```

n = 10 , left side = 1.47872752410878e-1
        1/n^(1/2) = 3.16227766016838e-1

```

```

        difference = 1.68355013605960e-1
n = 20 , left side = 9.78605569036920e-2
        1/n^(1/2) = 2.23606797749979e-1
        difference = 1.25746240846287e-1
n = 50 , left side = 3.38868135786706e-2
        1/n^(1/2) = 1.41421356237310e-1
        difference = 1.07534542658639e-1
n = 100 , left side = 1.54044053860311e-2
        1/n^(1/2) = 1.00000000000000e-1
        difference = 8.45955946139690e-2
n = 200 , left side = 7.31683725369414e-3
        1/n^(1/2) = 7.07106781186548e-2
        difference = 6.33938408649606e-2
n = 500 , left side = 2.83424719393494e-3
        1/n^(1/2) = 4.47213595499958e-2
        difference = 4.18871123560609e-2

```

$$x^3$$

```

n = 10 , left side = 1.73192000431425e-1
        1/n^(1/2) = 3.16227766016838e-1
        difference = 1.43035765585412e-1
n = 20 , left side = 1.03864925521532e-1
        1/n^(1/2) = 2.23606797749979e-1
        difference = 1.19741872228447e-1
n = 50 , left side = 3.05073733511566e-2
        1/n^(1/2) = 1.41421356237310e-1
        difference = 1.10913982886153e-1
n = 100 , left side = 1.27681795752463e-2
        1/n^(1/2) = 1.00000000000000e-1
        difference = 8.72318204247537e-2
n = 200 , left side = 5.78399942625291e-3
        1/n^(1/2) = 7.07106781186548e-2
        difference = 6.49266786924018e-2
n = 500 , left side = 2.17239948281694e-3
        1/n^(1/2) = 4.47213595499958e-2

```

difference = 4.25489600671788e-2

$$x^4$$

n = 10 , left side = 1.80257354696213e-1  
1/n^(1/2) = 3.16227766016838e-1  
difference = 1.35970411320625e-1  
n = 20 , left side = 9.63498090064419e-2  
1/n^(1/2) = 2.23606797749979e-1  
difference = 1.27256988743537e-1  
n = 50 , left side = 2.41914336230854e-2  
1/n^(1/2) = 1.41421356237310e-1  
difference = 1.17229922614224e-1  
n = 100 , left side = 9.37035404303933e-3  
1/n^(1/2) = 1.00000000000000e-1  
difference = 9.06296459569607e-2  
n = 200 , left side = 4.05904957310239e-3  
1/n^(1/2) = 7.07106781186548e-2  
difference = 6.66516285455524e-2  
n = 500 , left side = 1.47973714572884e-3  
1/n^(1/2) = 4.47213595499958e-2  
difference = 4.32416224042670e-2

$$x^{10}$$

n = 10 , left side = 1.19260700953333e-1  
1/n^(1/2) = 3.16227766016838e-1  
difference = 1.96967065063505e-1  
n = 20 , left side = 3.73465208237525e-2  
1/n^(1/2) = 2.23606797749979e-1  
difference = 1.86260276926226e-1  
n = 50 , left side = 2.80162956157203e-3  
1/n^(1/2) = 1.41421356237310e-1  
difference = 1.38619726675737e-1  
n = 100 , left side = 6.32905221145960e-4  
1/n^(1/2) = 1.00000000000000e-1



```

difference = 9.93670947788540e-2
n = 200 , left side = 2.12043953336416e-4
1/n^(1/2) = 7.07106781186548e-2
difference = 7.04986341653183e-2
n = 500 , left side = 6.54808182456543e-5
1/n^(1/2) = 4.47213595499958e-2
difference = 4.46558787317501e-2

```

-----  
x0 = 1/2, Power = 1/2, lamda = 1/2, q = 1  
-----

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 8.10134985303517e-2
1/n^(1/2) = 3.16227766016838e-1
difference = 2.35214267486486e-1
n = 20 , left side = 1.68560763315222e-2
1/n^(1/2) = 2.23606797749979e-1
difference = 2.06750721418457e-1
n = 50 , left side = 1.97802106438799e-3
1/n^(1/2) = 1.41421356237310e-1
difference = 1.39443335172922e-1
n = 100 , left side = 4.80026592954874e-4
1/n^(1/2) = 1.00000000000000e-1
difference = 9.95199734070451e-2
n = 200 , left side = 1.19239646471758e-4
1/n^(1/2) = 7.07106781186548e-2
difference = 7.05914384721830e-2
n = 500 , left side = 1.90449720898211e-5
1/n^(1/2) = 4.47213595499958e-2
difference = 4.47023145779060e-2

```

$$x$$

$n = 10$  , left side = 4.91637605442459e-2  
 $1/n^{(1/2)} = 3.16227766016838e-1$   
difference = 2.67064005472592e-1  
 $n = 20$  , left side = 3.39394250680031e-3  
 $1/n^{(1/2)} = 2.23606797749979e-1$   
difference = 2.20212855243179e-1  
 $n = 50$  , left side = 1.64890433873577e-6  
 $1/n^{(1/2)} = 1.41421356237310e-1$   
difference = 1.41419707332971e-1  
 $n = 100$  , left side = 5.86158899196221e-12  
 $1/n^{(1/2)} = 1.00000000000000e-1$   
difference = 9.99999999941384e-2  
 $n = 200$  , left side = 0.00000000000000e0  
 $1/n^{(1/2)} = 7.07106781186548e-2$   
difference = 7.07106781186548e-2  
 $n = 500$  , left side = 0.00000000000000e0  
 $1/n^{(1/2)} = 4.47213595499958e-2$   
difference = 4.47213595499958e-2

$$x^2$$

$n = 10$  , left side = 5.25230782287647e-2  
 $1/n^{(1/2)} = 3.16227766016838e-1$   
difference = 2.63704687788073e-1  
 $n = 20$  , left side = 2.83373415030338e-2  
 $1/n^{(1/2)} = 2.23606797749979e-1$   
difference = 1.95269456246945e-1  
 $n = 50$  , left side = 5.39457664221721e-3  
 $1/n^{(1/2)} = 1.41421356237310e-1$   
difference = 1.36026779595092e-1  
 $n = 100$  , left side = 1.34928057788147e-3  
 $1/n^{(1/2)} = 1.00000000000000e-1$   
difference = 9.86507194221185e-2  
 $n = 200$  , left side = 3.37320146703068e-4  
 $1/n^{(1/2)} = 7.07106781186548e-2$   
difference = 7.03733579719517e-2

n = 500 , left side = 5.39712234723932e-5  
 1/n^(1/2) = 4.47213595499958e-2  
 difference = 4.46673883265234e-2

$$x^3$$

n = 10 , left side = 8.22234506283697e-2  
 1/n^(1/2) = 3.16227766016838e-1  
 difference = 2.34004315388468e-1  
 n = 20 , left side = 4.36057626242193e-2  
 1/n^(1/2) = 2.23606797749979e-1  
 difference = 1.80001035125760e-1  
 n = 50 , left side = 8.09259320656261e-3  
 1/n^(1/2) = 1.41421356237310e-1  
 difference = 1.33328763030747e-1  
 n = 100 , left side = 2.02392086959322e-3  
 1/n^(1/2) = 1.00000000000000e-1  
 difference = 9.79760791304068e-2  
 n = 200 , left side = 5.05980220054464e-4  
 1/n^(1/2) = 7.07106781186548e-2  
 difference = 7.02046978986003e-2  
 n = 500 , left side = 8.09568352086454e-5  
 1/n^(1/2) = 4.47213595499958e-2  
 difference = 4.46404027147871e-2

$$x^4$$

n = 10 , left side = 1.01052973293562e-1  
 1/n^(1/2) = 3.16227766016838e-1  
 difference = 2.15174792723276e-1  
 n = 20 , left side = 4.67481413489399e-2  
 1/n^(1/2) = 2.23606797749979e-1  
 difference = 1.76858656401039e-1  
 n = 50 , left side = 8.21282675171929e-3  
 1/n^(1/2) = 1.41421356237310e-1  
 difference = 1.33208529485590e-1

```

n = 100 , left side = 2.03145927015683e-3
          1/n^(1/2) = 1.00000000000000e-1
          difference = 9.79685407298432e-2
n = 200 , left side = 5.06451370153246e-4
          1/n^(1/2) = 7.07106781186548e-2
          difference = 7.02042267485015e-2
n = 500 , left side = 8.09688966512401e-5
          1/n^(1/2) = 4.47213595499958e-2
          difference = 4.46403906533446e-2

```

$$x^{10}$$

```

n = 10 , left side = 7.01207124827066e-2
          1/n^(1/2) = 3.16227766016838e-1
          difference = 2.46107053534131e-1
n = 20 , left side = 2.01574704246336e-2
          1/n^(1/2) = 2.23606797749979e-1
          difference = 2.03449327325345e-1
n = 50 , left side = 1.42480124701181e-3
          1/n^(1/2) = 1.41421356237310e-1
          difference = 1.39996554990298e-1
n = 100 , left side = 2.63178146244665e-4
          1/n^(1/2) = 1.00000000000000e-1
          difference = 9.97368218537553e-2
n = 200 , left side = 6.08599933530729e-5
          1/n^(1/2) = 7.07106781186548e-2
          difference = 7.06498181253017e-2
n = 500 , left side = 9.52678517986811e-6
          1/n^(1/2) = 4.47213595499958e-2
          difference = 4.47118327648159e-2

```

-----  
x0 = 1/2, Power = 1/2, lamda = 1, q = 1/4  
-----

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 5.33369660315086e-2
          1/n^(1/2) = 3.16227766016838e-1
          difference = 2.62890799985329e-1
n = 20 , left side = 3.23728371506256e-2
          1/n^(1/2) = 2.23606797749979e-1
          difference = 1.91233960599353e-1
n = 50 , left side = 1.39366391997124e-2
          1/n^(1/2) = 1.41421356237310e-1
          difference = 1.27484717037597e-1
n = 100 , left side = 7.14621856758935e-3
          1/n^(1/2) = 1.00000000000000e-1
          difference = 9.28537814324107e-2
n = 200 , left side = 3.61961230894148e-3
          1/n^(1/2) = 7.07106781186548e-2
          difference = 6.70910658097133e-2
n = 500 , left side = 1.45930076253697e-3
          1/n^(1/2) = 4.47213595499958e-2
          difference = 4.32620587874588e-2

```

$$x$$

```

n = 10 , left side = 1.29071817455777e-1
          1/n^(1/2) = 3.16227766016838e-1
          difference = 1.87155948561061e-1
n = 20 , left side = 6.92514035886479e-2
          1/n^(1/2) = 2.23606797749979e-1
          difference = 1.54355394161331e-1
n = 50 , left side = 2.77258876437840e-2
          1/n^(1/2) = 1.41421356237310e-1
          difference = 1.13695468593525e-1
n = 100 , left side = 1.38629438314649e-2
          1/n^(1/2) = 1.00000000000000e-1
          difference = 8.61370561685351e-2
n = 200 , left side = 6.93147191573262e-3

```

```

1/n^(1/2) = 7.07106781186548e-2
difference = 6.37792062029221e-2
n = 500 , left side = 2.77258876629294e-3
1/n^(1/2) = 4.47213595499958e-2
difference = 4.19487707837029e-2

```

$$x^2$$

```

n = 10 , left side = 1.77390913518807e-1
1/n^(1/2) = 3.16227766016838e-1
difference = 1.38836852498031e-1
n = 20 , left side = 8.30737213816239e-2
1/n^(1/2) = 2.23606797749979e-1
difference = 1.40533076368355e-1
n = 50 , left side = 2.99438930027936e-2
1/n^(1/2) = 1.41421356237310e-1
difference = 1.11477463234516e-1
n = 100 , left side = 1.44174451738843e-2
1/n^(1/2) = 1.00000000000000e-1
difference = 8.55825548261157e-2
n = 200 , left side = 7.07009725133728e-3
1/n^(1/2) = 7.07106781186548e-2
difference = 6.36405808673175e-2
n = 500 , left side = 2.79476881998980e-3
1/n^(1/2) = 4.47213595499958e-2
difference = 4.19265907300060e-2

```

$$x^3$$

```

n = 10 , left side = 1.81706840017598e-1
1/n^(1/2) = 3.16227766016838e-1
difference = 1.34520925999240e-1
n = 20 , left side = 7.48642399521752e-2
1/n^(1/2) = 2.23606797749979e-1
difference = 1.48742557797804e-1
n = 50 , left side = 2.42632851043291e-2

```

$1/n^{(1/2)} = 1.41421356237310e-1$   
 difference = 1.17158071132980e-1  
 n = 100 , left side = 1.12466925545656e-2  
 $1/n^{(1/2)} = 1.00000000000000e-1$   
 difference = 8.87533074454344e-2  
 n = 200 , left side = 5.40875852362391e-3  
 $1/n^{(1/2)} = 7.07106781186548e-2$   
 difference = 6.53019195950308e-2  
 n = 500 , left side = 2.11285351660356e-3  
 $1/n^{(1/2)} = 4.47213595499958e-2$   
 difference = 4.26085060333922e-2

$$x^4$$

n = 10 , left side = 1.67787178069694e-1  
 $1/n^{(1/2)} = 3.16227766016838e-1$   
 difference = 1.48440587947144e-1  
 n = 20 , left side = 6.03397370785074e-2  
 $1/n^{(1/2)} = 2.23606797749979e-1$   
 difference = 1.63267060671472e-1  
 n = 50 , left side = 1.74893080184918e-2  
 $1/n^{(1/2)} = 1.41421356237310e-1$   
 difference = 1.23932048218818e-1  
 n = 100 , left side = 7.79966635748684e-3  
 $1/n^{(1/2)} = 1.00000000000000e-1$   
 difference = 9.22003336425132e-2  
 n = 200 , left side = 3.67816819644862e-3  
 $1/n^{(1/2)} = 7.07106781186548e-2$   
 difference = 6.70325099222061e-2  
 n = 500 , left side = 1.41984974971862e-3  
 $1/n^{(1/2)} = 4.47213595499958e-2$   
 difference = 4.33015098002772e-2

$$x^{10}$$

n = 10 , left side = 7.68027797084297e-2

```

1/n^(1/2) = 3.16227766016838e-1
difference = 2.39424986308408e-1
n = 20 , left side = 9.76146773173455e-3
1/n^(1/2) = 2.23606797749979e-1
difference = 2.13845330018244e-1
n = 50 , left side = 1.13068528957833e-3
1/n^(1/2) = 1.41421356237310e-1
difference = 1.40290670947731e-1
n = 100 , left side = 3.88474877995740e-4
1/n^(1/2) = 1.00000000000000e-1
difference = 9.96115251220043e-2
n = 200 , left side = 1.62038602245949e-4
1/n^(1/2) = 7.07106781186548e-2
difference = 7.05486395164088e-2
n = 500 , left side = 5.81892063838071e-5
1/n^(1/2) = 4.47213595499958e-2
difference = 4.46631703436120e-2

```

-----  
x0 = 1/2, Power = 1/2, lamda = 1, q = 1/2  
-----

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 1.96445247579275e-2
1/n^(1/2) = 3.16227766016838e-1
difference = 2.96583241258910e-1
n = 20 , left side = 1.48888789279410e-2
1/n^(1/2) = 2.23606797749979e-1
difference = 2.08717918822038e-1
n = 50 , left side = 6.77605354912036e-3
1/n^(1/2) = 1.41421356237310e-1
difference = 1.34645302688189e-1
n = 100 , left side = 3.52568356510696e-3
1/n^(1/2) = 1.00000000000000e-1

```



```

        difference = 9.64743164348930e-2
n = 200 , left side = 1.79801315131478e-3
        1/n^(1/2) = 7.07106781186548e-2
        difference = 6.89126649673400e-2
n = 500 , left side = 7.27768804896778e-4
        1/n^(1/2) = 4.47213595499958e-2
        difference = 4.39935907450990e-2

```

$x$

```

n = 10 , left side = 6.38935662496243e-2
        1/n^(1/2) = 3.16227766016838e-1
        difference = 2.52334199767214e-1
n = 20 , left side = 3.46235470985200e-2
        1/n^(1/2) = 2.23606797749979e-1
        difference = 1.88983250651459e-1
n = 50 , left side = 1.38629429714340e-2
        1/n^(1/2) = 1.41421356237310e-1
        difference = 1.27558413265876e-1
n = 100 , left side = 6.93147149063511e-3
        1/n^(1/2) = 1.00000000000000e-1
        difference = 9.30685285093649e-2
n = 200 , left side = 3.46573574531761e-3
        1/n^(1/2) = 7.07106781186548e-2
        difference = 6.72449423733371e-2
n = 500 , left side = 1.38629429812698e-3
        1/n^(1/2) = 4.47213595499958e-2
        difference = 4.33350652518688e-2

```

$x^2$

```

n = 10 , left side = 1.01231195168683e-1
        1/n^(1/2) = 3.16227766016838e-1
        difference = 2.14996570848155e-1
n = 20 , left side = 4.48623512045706e-2
        1/n^(1/2) = 2.23606797749979e-1

```

```

        difference = 1.78744446545408e-1
n = 50 , left side = 1.55044047114583e-2
        1/n^(1/2) = 1.41421356237310e-1
        difference = 1.25916951525851e-1
n = 100 , left side = 7.34183692697721e-3
        1/n^(1/2) = 1.00000000000000e-1
        difference = 9.26581630730228e-2
n = 200 , left side = 3.56832710440330e-3
        1/n^(1/2) = 7.07106781186548e-2
        difference = 6.71423510142515e-2
n = 500 , left side = 1.40270891558064e-3
        1/n^(1/2) = 4.47213595499958e-2
        difference = 4.33186506344152e-2

```

$$x^3$$

```

n = 10 , left side = 1.09051180141690e-1
        1/n^(1/2) = 3.16227766016838e-1
        difference = 2.07176585875148e-1
n = 20 , left side = 4.22970110547810e-2
        1/n^(1/2) = 2.23606797749979e-1
        difference = 1.81309786695198e-1
n = 50 , left side = 1.29223379237350e-2
        1/n^(1/2) = 1.41421356237310e-1
        difference = 1.28499018313574e-1
n = 100 , left side = 5.82201903348858e-3
        1/n^(1/2) = 1.00000000000000e-1
        difference = 9.41779809665114e-2
n = 200 , left side = 2.75417225524133e-3
        1/n^(1/2) = 7.07106781186548e-2
        difference = 6.79565058634134e-2
n = 500 , left side = 1.06440558786375e-3
        1/n^(1/2) = 4.47213595499958e-2
        difference = 4.36569539621320e-2

```

$$x^4$$

$n = 10$  , left side = 1.02540884681400e-1  
 $1/n^{(1/2)} = 3.16227766016838e-1$   
difference = 2.13686881335438e-1  
 $n = 20$  , left side = 3.49981874860215e-2  
 $1/n^{(1/2)} = 2.23606797749979e-1$   
difference = 1.88608610263957e-1  
 $n = 50$  , left side = 9.52960631552963e-3  
 $1/n^{(1/2)} = 1.41421356237310e-1$   
difference = 1.31891749921780e-1  
 $n = 100$  , left side = 4.09764755001933e-3  
 $1/n^{(1/2)} = 1.00000000000000e-1$   
difference = 9.59023524499807e-2  
 $n = 200$  , left side = 1.88876104704867e-3  
 $1/n^{(1/2)} = 7.07106781186548e-2$   
difference = 6.88219170716061e-2  
 $n = 500$  , left side = 7.17895958025169e-4  
 $1/n^{(1/2)} = 4.47213595499958e-2$   
difference = 4.40034635919706e-2

$$x^{10}$$

$n = 10$  , left side = 4.39432749437959e-2  
 $1/n^{(1/2)} = 3.16227766016838e-1$   
difference = 2.72284491073042e-1  
 $n = 20$  , left side = 5.59881198565935e-3  
 $1/n^{(1/2)} = 2.23606797749979e-1$   
difference = 2.18007985764320e-1  
 $n = 50$  , left side = 6.58122885628412e-4  
 $1/n^{(1/2)} = 1.41421356237310e-1$   
difference = 1.40763233351681e-1  
 $n = 100$  , left side = 2.17135216419487e-4  
 $1/n^{(1/2)} = 1.00000000000000e-1$   
difference = 9.97828647835805e-2  
 $n = 200$  , left side = 8.67799400498142e-5  
 $1/n^{(1/2)} = 7.07106781186548e-2$   
difference = 7.06238981786049e-2

```

n = 500 , left side = 3.00238003037257e-5
          1/n^(1/2) = 4.47213595499958e-2
          difference = 4.46913357496921e-2

```

```

-----
x0 = 1/2, Power = 1/2, lamda = 1,  q = 1
-----

```

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 1.88583358245117e-2
          1/n^(1/2) = 3.16227766016838e-1
          difference = 2.97369430192326e-1
n = 20 , left side = 3.43036193768773e-3
          1/n^(1/2) = 2.23606797749979e-1
          difference = 2.20176435812291e-1
n = 50 , left side = 5.15745217625430e-4
          1/n^(1/2) = 1.41421356237310e-1
          difference = 1.40905611019684e-1
n = 100 , left side = 1.28085535782918e-4
          1/n^(1/2) = 1.00000000000000e-1
          difference = 9.98719144642171e-2
n = 200 , left side = 3.19697272260777e-5
          1/n^(1/2) = 7.07106781186548e-2
          difference = 7.06787083914287e-2
n = 500 , left side = 5.11285838611375e-6
          1/n^(1/2) = 4.47213595499958e-2
          difference = 4.47162466916097e-2

```

$$x$$

```

n = 10 , left side = 3.03097878388942e-3
          1/n^(1/2) = 3.16227766016838e-1
          difference = 3.13196787232949e-1
n = 20 , left side = 1.79813965208164e-5

```

```

1/n^(1/2) = 2.23606797749979e-1
difference = 2.23588816353458e-1
n = 50 , left side = 5.04973840520506e-12
1/n^(1/2) = 1.41421356237310e-1
difference = 1.41421356232260e-1
n = 100 , left side = 0.000000000000000e0
1/n^(1/2) = 1.000000000000000e-1
difference = 1.000000000000000e-1
n = 200 , left side = 0.000000000000000e0
1/n^(1/2) = 7.07106781186548e-2
difference = 7.07106781186548e-2
n = 500 , left side = 0.000000000000000e0
1/n^(1/2) = 4.47213595499958e-2
difference = 4.47213595499958e-2

```

$$x^2$$

```

n = 10 , left side = 3.13288100022529e-2
1/n^(1/2) = 3.16227766016838e-1
difference = 2.84898956014585e-1
n = 20 , left side = 9.02981956494564e-3
1/n^(1/2) = 2.23606797749979e-1
difference = 2.14576978185033e-1
n = 50 , left side = 1.44928066358063e-3
1/n^(1/2) = 1.41421356237310e-1
difference = 1.39972075573729e-1
n = 100 , left side = 3.62320167826058e-4
1/n^(1/2) = 1.000000000000000e-1
difference = 9.96376798321739e-2
n = 200 , left side = 9.05800419564451e-5
1/n^(1/2) = 7.07106781186548e-2
difference = 7.06200980766983e-2
n = 500 , left side = 1.44928067127847e-5
1/n^(1/2) = 4.47213595499958e-2
difference = 4.47068667432830e-2

```

$$x^3$$

```

n = 10 , left side = 4.78600213916087e-2
          1/n^(1/2) = 3.16227766016838e-1
          difference = 2.68367744625229e-1
n = 20 , left side = 1.35520533206202e-2
          1/n^(1/2) = 2.23606797749979e-1
          difference = 2.10054744429359e-1
n = 50 , left side = 2.17392099772526e-3
          1/n^(1/2) = 1.41421356237310e-1
          difference = 1.39247435239584e-1
n = 100 , left side = 5.43480251739198e-4
          1/n^(1/2) = 1.00000000000000e-1
          difference = 9.94565197482608e-2
n = 200 , left side = 1.35870062934806e-4
          1/n^(1/2) = 7.07106781186548e-2
          difference = 7.05748080557199e-2
n = 500 , left side = 2.17392100697045e-5
          1/n^(1/2) = 4.47213595499958e-2
          difference = 4.46996203399261e-2

```

$$x^4$$

```

n = 10 , left side = 5.14533906505906e-2
          1/n^(1/2) = 3.16227766016838e-1
          difference = 2.64774375366247e-1
n = 20 , left side = 1.38732244570935e-2
          1/n^(1/2) = 2.23606797749979e-1
          difference = 2.09733573292885e-1
n = 50 , left side = 2.18227896612333e-3
          1/n^(1/2) = 1.41421356237310e-1
          difference = 1.39239077271186e-1
n = 100 , left side = 5.44002624822598e-4
          1/n^(1/2) = 1.00000000000000e-1
          difference = 9.94559973751774e-2
n = 200 , left side = 1.35902711252578e-4

```

```

1/n^(1/2) = 7.07106781186548e-2
difference = 7.05747754074022e-2
n = 500 , left side = 2.17400458665112e-5
1/n^(1/2) = 4.47213595499958e-2
difference = 4.46996195041293e-2

```

$$x^{10}$$

```

n = 10 , left side = 2.39574413183784e-2
1/n^(1/2) = 3.16227766016838e-1
difference = 2.92270324698460e-1
n = 20 , left side = 2.97086004062650e-3
1/n^(1/2) = 2.23606797749979e-1
difference = 2.20635937709352e-1
n = 50 , left side = 2.83599622557920e-4
1/n^(1/2) = 1.41421356237310e-1
difference = 1.41137756614752e-1
n = 100 , left side = 6.54249762593842e-5
1/n^(1/2) = 1.00000000000000e-1
difference = 9.99345750237406e-2
n = 200 , left side = 1.60297404173209e-5
1/n^(1/2) = 7.07106781186548e-2
difference = 7.06946483782374e-2
n = 500 , left side = 2.55030753033912e-6
1/n^(1/2) = 4.47213595499958e-2
difference = 4.47188092424655e-2

```

-----  
x0 = 1/2, Power = 7/10, lamda = 1/4, q = 1/4  
-----

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 7.33574282376017e-2
1/n^(7/10) = 1.99526231496888e-1

```

```

        difference = 1.26168803259286e-1
n = 20 , left side = 4.53841801182795e-2
        1/n^(7/10) = 1.22822802611579e-1
        difference = 7.74386224932996e-2
n = 50 , left side = 4.74957712877522e-2
        1/n^(7/10) = 6.46727006577358e-2
        difference = 1.71769293699835e-2
n = 100 , left side = 2.67013950556243e-2
        1/n^(7/10) = 3.98107170553497e-2
        difference = 1.31093219997254e-2
n = 200 , left side = 1.39773905392242e-2
        1/n^(7/10) = 2.45063709469745e-2
        difference = 1.05289804077503e-2
n = 500 , left side = 5.75326859927561e-3
        1/n^(7/10) = 1.29039002429643e-2
        difference = 7.15063164368872e-3

```

$x$

```

n = 10 , left side = 1.48505389324612e-2
        1/n^(7/10) = 1.99526231496888e-1
        difference = 1.84675692564427e-1
n = 20 , left side = 1.39174879467004e-1
        1/n^(7/10) = 1.22822802611579e-1
        difference = -1.63520768554254e-2
n = 50 , left side = 1.07608816899145e-1
        1/n^(7/10) = 6.46727006577358e-2
        difference = -4.29361162414096e-2
n = 100 , left side = 5.54452812788874e-2
        1/n^(7/10) = 3.98107170553497e-2
        difference = -1.56345642235376e-2
n = 200 , left side = 2.77258871979472e-2
        1/n^(7/10) = 2.45063709469745e-2
        difference = -3.21951625097272e-3
n = 500 , left side = 1.10903548889592e-2
        1/n^(7/10) = 1.29039002429643e-2

```



difference = 1.81354535400517e-3

$$x^2$$

n = 10 , left side = 1.94005188391137e-1  
1/n^(7/10) = 1.99526231496888e-1  
difference = 5.52104310575066e-3  
n = 20 , left side = 2.30868040947246e-1  
1/n^(7/10) = 1.22822802611579e-1  
difference = -1.08045238335667e-1  
n = 50 , left side = 1.38886956653740e-1  
1/n^(7/10) = 6.46727006577358e-2  
difference = -7.42142559960043e-2  
n = 100 , left side = 6.38134518553904e-2  
1/n^(7/10) = 3.98107170553497e-2  
difference = -2.40027348000407e-2  
n = 200 , left side = 2.98188925936178e-2  
1/n^(7/10) = 2.45063709469745e-2  
difference = -5.31252164664331e-3  
n = 500 , left side = 1.14252357544120e-2  
1/n^(7/10) = 1.29039002429643e-2  
difference = 1.47866448855231e-3

$$x^3$$

n = 10 , left side = 2.06175421900515e-1  
1/n^(7/10) = 1.99526231496888e-1  
difference = -6.64919040362652e-3  
n = 20 , left side = 2.53575282932135e-1  
1/n^(7/10) = 1.22822802611579e-1  
difference = -1.30752480320556e-1  
n = 50 , left side = 1.34595194359457e-1  
1/n^(7/10) = 6.46727006577358e-2  
difference = -6.99224937017212e-2  
n = 100 , left side = 5.51857590364190e-2  
1/n^(7/10) = 3.98107170553497e-2

```

        difference = -1.53750419810693e-2
n = 200 , left side = 2.40653876252187e-2
        1/n^(7/10) = 2.45063709469745e-2
        difference = 4.40983321755770e-4
n = 500 , left side = 8.82850116987996e-3
        1/n^(7/10) = 1.29039002429643e-2
        difference = 4.07539907308436e-3

```

$$x^4$$

```

n = 10 , left side = 2.45980444406422e-1
        1/n^(7/10) = 1.99526231496888e-1
        difference = -4.64542129095339e-2
n = 20 , left side = 2.51901006172595e-1
        1/n^(7/10) = 1.22822802611579e-1
        difference = -1.29078203561016e-1
n = 50 , left side = 1.17335729825915e-1
        1/n^(7/10) = 6.46727006577358e-2
        difference = -5.26630291681797e-2
n = 100 , left side = 4.25973806719297e-2
        1/n^(7/10) = 3.98107170553497e-2
        difference = -2.78666361657996e-3
n = 200 , left side = 1.72794180717638e-2
        1/n^(7/10) = 2.45063709469745e-2
        difference = 7.22695287521072e-3
n = 500 , left side = 6.06468552840353e-3
        1/n^(7/10) = 1.29039002429643e-2
        difference = 6.83921471456079e-3

```

$$x^{10}$$

```

n = 10 , left side = 1.88296929722229e-1
        1/n^(7/10) = 1.99526231496888e-1
        difference = 1.12293017746595e-2
n = 20 , left side = 1.57124987034018e-1
        1/n^(7/10) = 1.22822802611579e-1

```

```

        difference = -3.43021844224393e-2
n = 50 , left side = 3.56919049916328e-2
        1/n^(7/10) = 6.46727006577358e-2
        difference = 2.89807956661030e-2
n = 100 , left side = 4.80555765395147e-3
        1/n^(7/10) = 3.98107170553497e-2
        difference = 3.50051594013983e-2
n = 200 , left side = 1.09199033498743e-3
        1/n^(7/10) = 2.45063709469745e-2
        difference = 2.34143806119871e-2
n = 500 , left side = 2.84658201772995e-4
        1/n^(7/10) = 1.29039002429643e-2
        difference = 1.26192420411913e-2

```

-----  
x0 = 1/2, Power = 7/10, lamda = 1/4, q = 1/2  
-----

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 1.26504552641874e-1
        1/n^(7/10) = 1.99526231496888e-1
        difference = 7.30216788550137e-2
n = 20 , left side = 2.03548587742321e-2
        1/n^(7/10) = 1.22822802611579e-1
        difference = 1.02467943837347e-1
n = 50 , left side = 2.03304570248800e-2
        1/n^(7/10) = 6.46727006577358e-2
        difference = 4.43422436328557e-2
n = 100 , left side = 1.26409079150098e-2
        1/n^(7/10) = 3.98107170553497e-2
        difference = 2.71698091403399e-2
n = 200 , left side = 6.81868079261294e-3
        1/n^(7/10) = 2.45063709469745e-2
        difference = 1.76876901543616e-2

```

$n = 500$  , left side = 2.84988268112463e-3  
 $1/n^{(7/10)} = 1.29039002429643e-2$   
difference = 1.00540175618397e-2

$x$

$n = 10$  , left side = 8.02267409115550e-2  
 $1/n^{(7/10)} = 1.99526231496888e-1$   
difference = 1.19299490585333e-1  
 $n = 20$  , left side = 5.14929405767165e-2  
 $1/n^{(7/10)} = 1.22822802611579e-1$   
difference = 7.13298620348626e-2  
 $n = 50$  , left side = 5.36143926388598e-2  
 $1/n^{(7/10)} = 6.46727006577358e-2$   
difference = 1.10583080188759e-2  
 $n = 100$  , left side = 2.77224568458393e-2  
 $1/n^{(7/10)} = 3.98107170553497e-2$   
difference = 1.20882602095104e-2  
 $n = 200$  , left side = 1.38629435986308e-2  
 $1/n^{(7/10)} = 2.45063709469745e-2$   
difference = 1.06434273483437e-2  
 $n = 500$  , left side = 5.54517744447935e-3  
 $1/n^{(7/10)} = 1.29039002429643e-2$   
difference = 7.35872279848497e-3

$x^2$

$n = 10$  , left side = 1.28296366461717e-1  
 $1/n^{(7/10)} = 1.99526231496888e-1$   
difference = 7.12298650351712e-2  
 $n = 20$  , left side = 1.38397942935223e-1  
 $1/n^{(7/10)} = 1.22822802611579e-1$   
difference = -1.55751403236440e-2  
 $n = 50$  , left side = 7.67416652503929e-2  
 $1/n^{(7/10)} = 6.46727006577358e-2$   
difference = -1.20689645926572e-2

$n = 100$  , left side = 3.37863631986791e-2  
 $1/n^{(7/10)} = 3.98107170553497e-2$   
difference = 6.02435385667062e-3  
 $n = 200$  , left side = 1.53794053842907e-2  
 $1/n^{(7/10)} = 2.45063709469745e-2$   
difference = 9.12696556268378e-3  
 $n = 500$  , left side = 5.78781133126016e-3  
 $1/n^{(7/10)} = 1.29039002429643e-2$   
difference = 7.11608891170416e-3

$$x^3$$

$n = 10$  , left side = 1.27831704419723e-1  
 $1/n^{(7/10)} = 1.99526231496888e-1$   
difference = 7.16945270771649e-2  
 $n = 20$  , left side = 1.61344011208260e-1  
 $1/n^{(7/10)} = 1.22822802611579e-1$   
difference = -3.85212085966808e-2  
 $n = 50$  , left side = 7.78602100423141e-2  
 $1/n^{(7/10)} = 6.46727006577358e-2$   
difference = -1.31875093845784e-2  
 $n = 100$  , left side = 3.03485286276982e-2  
 $1/n^{(7/10)} = 3.98107170553497e-2$   
difference = 9.46218842765152e-3  
 $n = 200$  , left side = 1.27296398524397e-2  
 $1/n^{(7/10)} = 2.45063709469745e-2$   
difference = 1.17767310945348e-2  
 $n = 500$  , left side = 4.52652924015576e-3  
 $1/n^{(7/10)} = 1.29039002429643e-2$   
difference = 8.37737100280857e-3

$$x^4$$

$n = 10$  , left side = 1.84494512877635e-1  
 $1/n^{(7/10)} = 1.99526231496888e-1$   
difference = 1.50317186192532e-2

```

n = 20 , left side = 1.66506805511951e-1
          1/n^(7/10) = 1.22822802611579e-1
          difference = -4.36840029003720e-2
n = 50 , left side = 6.92290642748952e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = -4.55636361715944e-3
n = 100 , left side = 2.40205845419831e-2
          1/n^(7/10) = 3.98107170553497e-2
          difference = 1.57901325133667e-2
n = 200 , left side = 9.33054650504601e-3
          1/n^(7/10) = 2.45063709469745e-2
          difference = 1.51758244419285e-2
n = 500 , left side = 3.14415812448704e-3
          1/n^(7/10) = 1.29039002429643e-2
          difference = 9.75974211847728e-3

```

$$x^{10}$$

```

n = 10 , left side = 1.40771586828727e-1
          1/n^(7/10) = 1.99526231496888e-1
          difference = 5.87546446681609e-2
n = 20 , left side = 1.00214745282116e-1
          1/n^(7/10) = 1.22822802611579e-1
          difference = 2.26080573294634e-2
n = 50 , left side = 1.99853845577975e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = 4.46873160999382e-2
n = 100 , left side = 2.75646208624215e-3
          1/n^(7/10) = 3.98107170553497e-2
          difference = 3.70542549691076e-2
n = 200 , left side = 6.26624240120877e-4
          1/n^(7/10) = 2.45063709469745e-2
          difference = 2.38797467068536e-2
n = 500 , left side = 1.55217235579062e-4
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.27486830073853e-2

```

-----  
x0 = 1/2, Power = 7/10, lamda = 1/4, q = 1  
-----

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 2.09749541545875e-1
          1/n^(7/10) = 1.99526231496888e-1
          difference = -1.02233100489870e-2
n = 20 , left side = 7.85812770396360e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 4.42415255719431e-2
n = 50 , left side = 9.34393044496805e-3
          1/n^(7/10) = 6.46727006577358e-2
          difference = 5.53287702127677e-2
n = 100 , left side = 1.94070471300620e-3
          1/n^(7/10) = 3.98107170553497e-2
          difference = 3.78700123423435e-2
n = 200 , left side = 4.71100029514671e-4
          1/n^(7/10) = 2.45063709469745e-2
          difference = 2.40352709174598e-2
n = 500 , left side = 7.48422627483425e-5
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.28290579802160e-2

```

$$x$$

```

n = 10 , left side = 2.08951638220122e-1
          1/n^(7/10) = 1.99526231496888e-1
          difference = -9.42540672323408e-3
n = 20 , left side = 5.25889244914822e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 7.02338781200969e-2
n = 50 , left side = 1.01379455384021e-3

```

```

1/n^(7/10) = 6.46727006577358e-2
difference = 6.36589061038955e-2
n = 100 , left side = 1.80708522862227e-6
1/n^(7/10) = 3.98107170553497e-2
difference = 3.98089099701211e-2
n = 200 , left side = 6.45467013171697e-12
1/n^(7/10) = 2.45063709469745e-2
difference = 2.45063709405198e-2
n = 500 , left side = 0.000000000000000e0
1/n^(7/10) = 1.29039002429643e-2
difference = 1.29039002429643e-2

```

$$x^2$$

```

n = 10 , left side = 6.09251809834974e-2
1/n^(7/10) = 1.99526231496888e-1
difference = 1.38601050513391e-1
n = 20 , left side = 4.57428235934711e-2
1/n^(7/10) = 1.22822802611579e-1
difference = 7.70799790181080e-2
n = 50 , left side = 1.96014797649490e-2
1/n^(7/10) = 6.46727006577358e-2
difference = 4.50712208927868e-2
n = 100 , left side = 5.29434230595233e-3
1/n^(7/10) = 3.98107170553497e-2
difference = 3.45163747493974e-2
n = 200 , left side = 1.32428057699463e-3
1/n^(7/10) = 2.45063709469745e-2
difference = 2.31820903699799e-2
n = 500 , left side = 2.11884893889736e-4
1/n^(7/10) = 1.29039002429643e-2
difference = 1.26920153490746e-2

```

$$x^3$$

```

n = 10 , left side = 3.81659578000774e-2

```



```

1/n^(7/10) = 1.99526231496888e-1
difference = 1.61360273696811e-1
n = 20 , left side = 7.43081431790645e-2
1/n^(7/10) = 1.22822802611579e-1
difference = 4.85146594325146e-2
n = 50 , left side = 2.97879650699726e-2
1/n^(7/10) = 6.46727006577358e-2
difference = 3.48847355877632e-2
n = 100 , left side = 7.94232255998317e-3
1/n^(7/10) = 3.98107170553497e-2
difference = 3.18683944953666e-2
n = 200 , left side = 1.98642086856246e-3
1/n^(7/10) = 2.45063709469745e-2
difference = 2.25199500784120e-2
n = 500 , left side = 3.17827340834853e-4
1/n^(7/10) = 1.29039002429643e-2
difference = 1.25860729021295e-2

```

$$x^4$$

```

n = 10 , left side = 1.25757444757586e-1
1/n^(7/10) = 1.99526231496888e-1
difference = 7.37687867393017e-2
n = 20 , left side = 9.19703672747021e-2
1/n^(7/10) = 1.22822802611579e-1
difference = 3.08524353368769e-2
n = 50 , left side = 3.13124123712135e-2
1/n^(7/10) = 6.46727006577358e-2
difference = 3.33602882865223e-2
n = 100 , left side = 8.05935138518928e-3
1/n^(7/10) = 3.98107170553497e-2
difference = 3.17513656701605e-2
n = 200 , left side = 1.99376000196878e-3
1/n^(7/10) = 2.45063709469745e-2
difference = 2.25126109450057e-2
n = 500 , left side = 3.18015222677798e-4

```

$1/n^{(7/10)} = 1.29039002429643e-2$   
 $\text{difference} = 1.25858850202865e-2$

$$x^{10}$$

$n = 10$  , left side =  $9.92211518367574e-2$   
 $1/n^{(7/10)} = 1.99526231496888e-1$   
 $\text{difference} = 1.00305079660131e-1$   
 $n = 20$  , left side =  $5.87860822296067e-2$   
 $1/n^{(7/10)} = 1.22822802611579e-1$   
 $\text{difference} = 6.40367203819724e-2$   
 $n = 50$  , left side =  $1.06402237950819e-2$   
 $1/n^{(7/10)} = 6.46727006577358e-2$   
 $\text{difference} = 5.40324768626539e-2$   
 $n = 100$  , left side =  $1.39397823915505e-3$   
 $1/n^{(7/10)} = 3.98107170553497e-2$   
 $\text{difference} = 3.84167388161947e-2$   
 $n = 200$  , left side =  $2.58092754851807e-4$   
 $1/n^{(7/10)} = 2.45063709469745e-2$   
 $\text{difference} = 2.42482781921227e-2$   
 $n = 500$  , left side =  $3.78668260722235e-5$   
 $1/n^{(7/10)} = 1.29039002429643e-2$   
 $\text{difference} = 1.28660334168921e-2$

-----  
 $x_0 = 1/2$ , Power =  $7/10$ , lamda =  $1/2$ ,  $q = 1/4$   
 -----

$$x^{\frac{1}{3}}$$

$n = 10$  , left side =  $4.65939350634126e-2$   
 $1/n^{(7/10)} = 1.99526231496888e-1$   
 $\text{difference} = 1.52932296433475e-1$   
 $n = 20$  , left side =  $5.39175273339060e-2$   
 $1/n^{(7/10)} = 1.22822802611579e-1$

```

        difference = 6.89052752776731e-2
n = 50 , left side = 2.66706958509519e-2
        1/n^(7/10) = 6.46727006577358e-2
        difference = 3.80020048067839e-2
n = 100 , left side = 1.39692422376499e-2
        1/n^(7/10) = 3.98107170553497e-2
        difference = 2.58414748176998e-2
n = 200 , left side = 7.15466879542803e-3
        1/n^(7/10) = 2.45063709469745e-2
        difference = 1.73517021515465e-2
n = 500 , left side = 2.90466167844949e-3
        1/n^(7/10) = 1.29039002429643e-2
        difference = 9.99923856451483e-3

```

$x$

```

n = 10 , left side = 1.46960541508878e-1
        1/n^(7/10) = 1.99526231496888e-1
        difference = 5.25656899880097e-2
n = 20 , left side = 1.28044818944893e-1
        1/n^(7/10) = 1.22822802611579e-1
        difference = -5.22201633331423e-3
n = 50 , left side = 5.54458428059441e-2
        1/n^(7/10) = 6.46727006577358e-2
        difference = 9.22685785179164e-3
n = 100 , left side = 2.77258872001895e-2
        1/n^(7/10) = 3.98107170553497e-2
        difference = 1.20848298551602e-2
n = 200 , left side = 1.38629436111990e-2
        1/n^(7/10) = 2.45063709469745e-2
        difference = 1.06434273357755e-2
n = 500 , left side = 5.54517744447969e-3
        1/n^(7/10) = 1.29039002429643e-2
        difference = 7.35872279848464e-3

```

$x^2$

$n = 10$  , left side = 2.44068957215094e-1  
 $1/n^{(7/10)} = 1.99526231496888e-1$   
difference = -4.45427257182058e-2  
 $n = 20$  , left side = 1.73393496362237e-1  
 $1/n^{(7/10)} = 1.22822802611579e-1$   
difference = -5.05706937506581e-2  
 $n = 50$  , left side = 6.39143140576404e-2  
 $1/n^{(7/10)} = 6.46727006577358e-2$   
difference = 7.58386600095390e-4  
 $n = 100$  , left side = 2.98438925970290e-2  
 $1/n^{(7/10)} = 3.98107170553497e-2$   
difference = 9.96682445832077e-3  
 $n = 200$  , left side = 1.43924449634690e-2  
 $1/n^{(7/10)} = 2.45063709469745e-2$   
difference = 1.01139259835055e-2  
 $n = 500$  , left side = 5.62989766084282e-3  
 $1/n^{(7/10)} = 1.29039002429643e-2$   
difference = 7.27400258212150e-3

$$x^3$$

$n = 10$  , left side = 2.70532081486956e-1  
 $1/n^{(7/10)} = 1.99526231496888e-1$   
difference = -7.10058499900679e-2  
 $n = 20$  , left side = 1.75303858260733e-1  
 $1/n^{(7/10)} = 1.22822802611579e-1$   
difference = -5.24810556491538e-2  
 $n = 50$  , left side = 5.53534166881952e-2  
 $1/n^{(7/10)} = 6.46727006577358e-2$   
difference = 9.31928396954054e-3  
 $n = 100$  , left side = 2.41049670707779e-2  
 $1/n^{(7/10)} = 3.98107170553497e-2$   
difference = 1.57057499845718e-2  
 $n = 200$  , left side = 1.12081526845386e-2  
 $1/n^{(7/10)} = 2.45063709469745e-2$   
difference = 1.32982182624359e-2

n = 500 , left side = 4.28703175655956e-3  
 1/n^(7/10) = 1.29039002429643e-2  
 difference = 8.61686848640476e-3

$$x^4$$

n = 10 , left side = 2.71811655321145e-1  
 1/n^(7/10) = 1.99526231496888e-1  
 difference = -7.22854238242565e-2  
 n = 20 , left side = 1.59700780897926e-1  
 1/n^(7/10) = 1.22822802611579e-1  
 difference = -3.68779782863466e-2  
 n = 50 , left side = 4.27867893894553e-2  
 1/n^(7/10) = 6.46727006577358e-2  
 difference = 2.18859112682804e-2  
 n = 100 , left side = 1.73213915349858e-2  
 1/n^(7/10) = 3.98107170553497e-2  
 difference = 2.24893255203640e-2  
 n = 200 , left side = 7.76000677274190e-3  
 1/n^(7/10) = 2.45063709469745e-2  
 difference = 1.67463641742326e-2  
 n = 500 , left side = 2.90182870840235e-3  
 1/n^(7/10) = 1.29039002429643e-2  
 difference = 1.00020715345620e-2

$$x^{10}$$

n = 10 , left side = 1.86850823331552e-1  
 1/n^(7/10) = 1.99526231496888e-1  
 difference = 1.26754081653363e-2  
 n = 20 , left side = 6.58347789205075e-2  
 1/n^(7/10) = 1.22822802611579e-1  
 difference = 5.69880236910715e-2  
 n = 50 , left side = 4.87085072187460e-3  
 1/n^(7/10) = 6.46727006577358e-2  
 difference = 5.98018499358612e-2

```

n = 100 , left side = 1.09970741430996e-3
          1/n^(7/10) = 3.98107170553497e-2
          difference = 3.87110096410398e-2
n = 200 , left side = 3.82804893814840e-4
          1/n^(7/10) = 2.45063709469745e-2
          difference = 2.41235660531597e-2
n = 500 , left side = 1.24276968148319e-4
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.27796232748160e-2

```

-----  
x0 = 1/2, Power = 7/10, lamda = 1/2, q = 1/2  
-----

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 1.96080052578451e-2
          1/n^(7/10) = 1.99526231496888e-1
          difference = 1.79918226239043e-1
n = 20 , left side = 2.08299179386357e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 1.01992884672943e-1
n = 50 , left side = 1.26071386109590e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = 5.20655620467768e-2
n = 100 , left side = 6.81015763376180e-3
          1/n^(7/10) = 3.98107170553497e-2
          difference = 3.30005594215879e-2
n = 200 , left side = 3.53432821873068e-3
          1/n^(7/10) = 2.45063709469745e-2
          difference = 2.09720427282438e-2
n = 500 , left side = 1.44549650366432e-3
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.14584037393000e-2

```

$x$

```
n = 10 , left side = 5.68097172543790e-2
          1/n^(7/10) = 1.99526231496888e-1
          difference = 1.42716514242509e-1
n = 20 , left side = 6.32752819000140e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 5.95475207115651e-2
n = 50 , left side = 2.77227554082918e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = 3.69499452494439e-2
n = 100 , left side = 1.38629435997858e-2
          1/n^(7/10) = 3.98107170553497e-2
          difference = 2.59477734555639e-2
n = 200 , left side = 6.93147180559950e-3
          1/n^(7/10) = 2.45063709469745e-2
          difference = 1.75748991413750e-2
n = 500 , left side = 2.77258872223984e-3
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.01313115207245e-2
```

$x^2$

```
n = 10 , left side = 1.47872752410878e-1
          1/n^(7/10) = 1.99526231496888e-1
          difference = 5.16534790860097e-2
n = 20 , left side = 9.78605569036920e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 2.49622457078870e-2
n = 50 , left side = 3.38868135786706e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = 3.07858870790652e-2
n = 100 , left side = 1.54044053860311e-2
          1/n^(7/10) = 3.98107170553497e-2
          difference = 2.44063116693187e-2
n = 200 , left side = 7.31683725369414e-3
```

```

1/n^(7/10) = 2.45063709469745e-2
difference = 1.71895336932804e-2
n = 500 , left side = 2.83424719393494e-3
1/n^(7/10) = 1.29039002429643e-2
difference = 1.00696530490294e-2

```

$$x^3$$

```

n = 10 , left side = 1.73192000431425e-1
1/n^(7/10) = 1.99526231496888e-1
difference = 2.63342310654625e-2
n = 20 , left side = 1.03864925521532e-1
1/n^(7/10) = 1.22822802611579e-1
difference = 1.89578770900470e-2
n = 50 , left side = 3.05073733511566e-2
1/n^(7/10) = 6.46727006577358e-2
difference = 3.41653273065791e-2
n = 100 , left side = 1.27681795752463e-2
1/n^(7/10) = 3.98107170553497e-2
difference = 2.70425374801034e-2
n = 200 , left side = 5.78399942625291e-3
1/n^(7/10) = 2.45063709469745e-2
difference = 1.87223715207216e-2
n = 500 , left side = 2.17239948281694e-3
1/n^(7/10) = 1.29039002429643e-2
difference = 1.07315007601474e-2

```

$$x^4$$

```

n = 10 , left side = 1.80257354696213e-1
1/n^(7/10) = 1.99526231496888e-1
difference = 1.92688768006752e-2
n = 20 , left side = 9.63498090064419e-2
1/n^(7/10) = 1.22822802611579e-1
difference = 2.64729936051372e-2
n = 50 , left side = 2.41914336230854e-2

```



```

1/n^(7/10) = 6.46727006577358e-2
difference = 4.04812670346504e-2
n = 100 , left side = 9.37035404303933e-3
1/n^(7/10) = 3.98107170553497e-2
difference = 3.04403630123104e-2
n = 200 , left side = 4.05904957310239e-3
1/n^(7/10) = 2.45063709469745e-2
difference = 2.04473213738721e-2
n = 500 , left side = 1.47973714572884e-3
1/n^(7/10) = 1.29039002429643e-2
difference = 1.14241630972355e-2

```

$$x^{10}$$

```

n = 10 , left side = 1.19260700953333e-1
1/n^(7/10) = 1.99526231496888e-1
difference = 8.02655305435546e-2
n = 20 , left side = 3.73465208237525e-2
1/n^(7/10) = 1.22822802611579e-1
difference = 8.54762817878265e-2
n = 50 , left side = 2.80162956157203e-3
1/n^(7/10) = 6.46727006577358e-2
difference = 6.18710710961637e-2
n = 100 , left side = 6.32905221145960e-4
1/n^(7/10) = 3.98107170553497e-2
difference = 3.91778118342038e-2
n = 200 , left side = 2.12043953336416e-4
1/n^(7/10) = 2.45063709469745e-2
difference = 2.42943269936381e-2
n = 500 , left side = 6.54808182456543e-5
1/n^(7/10) = 1.29039002429643e-2
difference = 1.28384194247187e-2

```

---

x0 = 1/2, Power = 7/10, lamda = 1/2, q = 1

---


$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 8.10134985303517e-2
          1/n^(7/10) = 1.99526231496888e-1
          difference = 1.18512732966536e-1
n = 20 , left side = 1.68560763315222e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 1.05966726280057e-1
n = 50 , left side = 1.97802106438799e-3
          1/n^(7/10) = 6.46727006577358e-2
          difference = 6.26946795933478e-2
n = 100 , left side = 4.80026592954874e-4
          1/n^(7/10) = 3.98107170553497e-2
          difference = 3.93306904623949e-2
n = 200 , left side = 1.19239646471758e-4
          1/n^(7/10) = 2.45063709469745e-2
          difference = 2.43871313005027e-2
n = 500 , left side = 1.90449720898211e-5
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.28848552708745e-2

```

$$x$$

```

n = 10 , left side = 4.91637605442459e-2
          1/n^(7/10) = 1.99526231496888e-1
          difference = 1.50362470952642e-1
n = 20 , left side = 3.39394250680031e-3
          1/n^(7/10) = 1.22822802611579e-1
          difference = 1.19428860104779e-1
n = 50 , left side = 1.64890433873577e-6
          1/n^(7/10) = 6.46727006577358e-2
          difference = 6.46710517533970e-2
n = 100 , left side = 5.86158899196221e-12
          1/n^(7/10) = 3.98107170553497e-2

```

```

        difference = 3.98107170494881e-2
n = 200 , left side = 0.000000000000000e0
        1/n^(7/10) = 2.45063709469745e-2
        difference = 2.45063709469745e-2
n = 500 , left side = 0.000000000000000e0
        1/n^(7/10) = 1.29039002429643e-2
        difference = 1.29039002429643e-2

```

$$x^2$$

```

n = 10 , left side = 5.25230782287647e-2
        1/n^(7/10) = 1.99526231496888e-1
        difference = 1.47003153268123e-1
n = 20 , left side = 2.83373415030338e-2
        1/n^(7/10) = 1.22822802611579e-1
        difference = 9.44854611085452e-2
n = 50 , left side = 5.39457664221721e-3
        1/n^(7/10) = 6.46727006577358e-2
        difference = 5.92781240155185e-2
n = 100 , left side = 1.34928057788147e-3
        1/n^(7/10) = 3.98107170553497e-2
        difference = 3.84614364774683e-2
n = 200 , left side = 3.37320146703068e-4
        1/n^(7/10) = 2.45063709469745e-2
        difference = 2.41690508002714e-2
n = 500 , left side = 5.39712234723932e-5
        1/n^(7/10) = 1.29039002429643e-2
        difference = 1.28499290194919e-2

```

$$x^3$$

```

n = 10 , left side = 8.22234506283697e-2
        1/n^(7/10) = 1.99526231496888e-1
        difference = 1.17302780868518e-1
n = 20 , left side = 4.36057626242193e-2
        1/n^(7/10) = 1.22822802611579e-1

```

```

        difference = 7.92170399873597e-2
n = 50 , left side = 8.09259320656261e-3
        1/n^(7/10) = 6.46727006577358e-2
        difference = 5.65801074511731e-2
n = 100 , left side = 2.02392086959322e-3
        1/n^(7/10) = 3.98107170553497e-2
        difference = 3.77867961857565e-2
n = 200 , left side = 5.05980220054464e-4
        1/n^(7/10) = 2.45063709469745e-2
        difference = 2.40003907269200e-2
n = 500 , left side = 8.09568352086454e-5
        1/n^(7/10) = 1.29039002429643e-2
        difference = 1.28229434077557e-2

```

$$x^4$$

```

n = 10 , left side = 1.01052973293562e-1
        1/n^(7/10) = 1.99526231496888e-1
        difference = 9.84732582033261e-2
n = 20 , left side = 4.67481413489399e-2
        1/n^(7/10) = 1.22822802611579e-1
        difference = 7.60746612626391e-2
n = 50 , left side = 8.21282675171929e-3
        1/n^(7/10) = 6.46727006577358e-2
        difference = 5.64598739060165e-2
n = 100 , left side = 2.03145927015683e-3
        1/n^(7/10) = 3.98107170553497e-2
        difference = 3.77792577851929e-2
n = 200 , left side = 5.06451370153246e-4
        1/n^(7/10) = 2.45063709469745e-2
        difference = 2.39999195768213e-2
n = 500 , left side = 8.09688966512401e-5
        1/n^(7/10) = 1.29039002429643e-2
        difference = 1.28229313463131e-2

```

$$x^{10}$$

```

n = 10 , left side = 7.01207124827066e-2
          1/n^(7/10) = 1.99526231496888e-1
          difference = 1.29405519014181e-1
n = 20 , left side = 2.01574704246336e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 1.02665332186945e-1
n = 50 , left side = 1.42480124701181e-3
          1/n^(7/10) = 6.46727006577358e-2
          difference = 6.32478994107240e-2
n = 100 , left side = 2.63178146244665e-4
          1/n^(7/10) = 3.98107170553497e-2
          difference = 3.95475389091051e-2
n = 200 , left side = 6.08599933530729e-5
          1/n^(7/10) = 2.45063709469745e-2
          difference = 2.44455109536214e-2
n = 500 , left side = 9.52678517986811e-6
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.28943734577845e-2

```

-----  
x0 = 1/2, Power = 7/10, lamda = 1, q = 1/4  
-----

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 5.33369660315086e-2
          1/n^(7/10) = 1.99526231496888e-1
          difference = 1.46189265465379e-1
n = 20 , left side = 3.23728371506256e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 9.04499654609535e-2
n = 50 , left side = 1.39366391997124e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = 5.07360614580233e-2
n = 100 , left side = 7.14621856758935e-3

```

```

1/n^(7/10) = 3.98107170553497e-2
difference = 3.26644984877604e-2
n = 200 , left side = 3.61961230894148e-3
1/n^(7/10) = 2.45063709469745e-2
difference = 2.08867586380330e-2
n = 500 , left side = 1.45930076253697e-3
1/n^(7/10) = 1.29039002429643e-2
difference = 1.14445994804273e-2

```

$x$

```

n = 10 , left side = 1.29071817455777e-1
1/n^(7/10) = 1.99526231496888e-1
difference = 7.04544140411110e-2
n = 20 , left side = 6.92514035886479e-2
1/n^(7/10) = 1.22822802611579e-1
difference = 5.35713990229311e-2
n = 50 , left side = 2.77258876437840e-2
1/n^(7/10) = 6.46727006577358e-2
difference = 3.69468130139517e-2
n = 100 , left side = 1.38629438314649e-2
1/n^(7/10) = 3.98107170553497e-2
difference = 2.59477732238848e-2
n = 200 , left side = 6.93147191573262e-3
1/n^(7/10) = 2.45063709469745e-2
difference = 1.75748990312419e-2
n = 500 , left side = 2.77258876629294e-3
1/n^(7/10) = 1.29039002429643e-2
difference = 1.01313114766714e-2

```

$x^2$

```

n = 10 , left side = 1.77390913518807e-1
1/n^(7/10) = 1.99526231496888e-1
difference = 2.21353179780807e-2
n = 20 , left side = 8.30737213816239e-2

```

```

1/n^(7/10) = 1.22822802611579e-1
difference = 3.97490812299551e-2
n = 50 , left side = 2.99438930027936e-2
1/n^(7/10) = 6.46727006577358e-2
difference = 3.47288076549422e-2
n = 100 , left side = 1.44174451738843e-2
1/n^(7/10) = 3.98107170553497e-2
difference = 2.53932718814655e-2
n = 200 , left side = 7.07009725133728e-3
1/n^(7/10) = 2.45063709469745e-2
difference = 1.74362736956372e-2
n = 500 , left side = 2.79476881998980e-3
1/n^(7/10) = 1.29039002429643e-2
difference = 1.01091314229745e-2

```

$$x^3$$

```

n = 10 , left side = 1.81706840017598e-1
1/n^(7/10) = 1.99526231496888e-1
difference = 1.78193914792899e-2
n = 20 , left side = 7.48642399521752e-2
1/n^(7/10) = 1.22822802611579e-1
difference = 4.79585626594039e-2
n = 50 , left side = 2.42632851043291e-2
1/n^(7/10) = 6.46727006577358e-2
difference = 4.04094155534067e-2
n = 100 , left side = 1.12466925545656e-2
1/n^(7/10) = 3.98107170553497e-2
difference = 2.85640245007841e-2
n = 200 , left side = 5.40875852362391e-3
1/n^(7/10) = 2.45063709469745e-2
difference = 1.90976124233506e-2
n = 500 , left side = 2.11285351660356e-3
1/n^(7/10) = 1.29039002429643e-2
difference = 1.07910467263608e-2

```

$$x^4$$

```

n = 10 , left side = 1.67787178069694e-1
          1/n^(7/10) = 1.99526231496888e-1
          difference = 3.17390534271939e-2
n = 20 , left side = 6.03397370785074e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 6.24830655330717e-2
n = 50 , left side = 1.74893080184918e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = 4.71833926392439e-2
n = 100 , left side = 7.79966635748684e-3
          1/n^(7/10) = 3.98107170553497e-2
          difference = 3.20110506978629e-2
n = 200 , left side = 3.67816819644862e-3
          1/n^(7/10) = 2.45063709469745e-2
          difference = 2.08282027505259e-2
n = 500 , left side = 1.41984974971862e-3
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.14840504932457e-2

```

$$x^{10}$$

```

n = 10 , left side = 7.68027797084297e-2
          1/n^(7/10) = 1.99526231496888e-1
          difference = 1.22723451788458e-1
n = 20 , left side = 9.76146773173455e-3
          1/n^(7/10) = 1.22822802611579e-1
          difference = 1.13061334879844e-1
n = 50 , left side = 1.13068528957833e-3
          1/n^(7/10) = 6.46727006577358e-2
          difference = 6.35420153681574e-2
n = 100 , left side = 3.88474877995740e-4
          1/n^(7/10) = 3.98107170553497e-2
          difference = 3.94222421773540e-2
n = 200 , left side = 1.62038602245949e-4

```



```

1/n^(7/10) = 2.45063709469745e-2
difference = 2.43443323447286e-2
n = 500 , left side = 5.81892063838071e-5
1/n^(7/10) = 1.29039002429643e-2
difference = 1.28457110365805e-2

```

-----  
x0 = 1/2, Power = 7/10, lamda = 1, q = 1/2  
-----

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 1.96445247579275e-2
1/n^(7/10) = 1.99526231496888e-1
difference = 1.79881706738960e-1
n = 20 , left side = 1.48888789279410e-2
1/n^(7/10) = 1.22822802611579e-1
difference = 1.07933923683638e-1
n = 50 , left side = 6.77605354912036e-3
1/n^(7/10) = 6.46727006577358e-2
difference = 5.78966471086154e-2
n = 100 , left side = 3.52568356510696e-3
1/n^(7/10) = 3.98107170553497e-2
difference = 3.62850334902428e-2
n = 200 , left side = 1.79801315131478e-3
1/n^(7/10) = 2.45063709469745e-2
difference = 2.27083577956597e-2
n = 500 , left side = 7.27768804896778e-4
1/n^(7/10) = 1.29039002429643e-2
difference = 1.21761314380675e-2

```

$$x$$

```

n = 10 , left side = 6.38935662496243e-2
1/n^(7/10) = 1.99526231496888e-1

```

```

        difference = 1.35632665247264e-1
n = 20 , left side = 3.46235470985200e-2
        1/n^(7/10) = 1.22822802611579e-1
        difference = 8.81992555130590e-2
n = 50 , left side = 1.38629429714340e-2
        1/n^(7/10) = 6.46727006577358e-2
        difference = 5.08097576863018e-2
n = 100 , left side = 6.93147149063511e-3
        1/n^(7/10) = 3.98107170553497e-2
        difference = 3.28792455647146e-2
n = 200 , left side = 3.46573574531761e-3
        1/n^(7/10) = 2.45063709469745e-2
        difference = 2.10406352016569e-2
n = 500 , left side = 1.38629429812698e-3
        1/n^(7/10) = 1.29039002429643e-2
        difference = 1.15176059448373e-2

```

$$x^2$$

```

n = 10 , left side = 1.01231195168683e-1
        1/n^(7/10) = 1.99526231496888e-1
        difference = 9.82950363282051e-2
n = 20 , left side = 4.48623512045706e-2
        1/n^(7/10) = 1.22822802611579e-1
        difference = 7.79604514070084e-2
n = 50 , left side = 1.55044047114583e-2
        1/n^(7/10) = 6.46727006577358e-2
        difference = 4.91682959462775e-2
n = 100 , left side = 7.34183692697721e-3
        1/n^(7/10) = 3.98107170553497e-2
        difference = 3.24688801283725e-2
n = 200 , left side = 3.56832710440330e-3
        1/n^(7/10) = 2.45063709469745e-2
        difference = 2.09380438425712e-2
n = 500 , left side = 1.40270891558064e-3
        1/n^(7/10) = 1.29039002429643e-2

```

difference = 1.15011913273837e-2

$$x^3$$

n = 10 , left side = 1.09051180141690e-1  
1/n^(7/10) = 1.99526231496888e-1  
difference = 9.04750513551982e-2  
n = 20 , left side = 4.22970110547810e-2  
1/n^(7/10) = 1.22822802611579e-1  
difference = 8.05257915567980e-2  
n = 50 , left side = 1.29223379237350e-2  
1/n^(7/10) = 6.46727006577358e-2  
difference = 5.17503627340007e-2  
n = 100 , left side = 5.82201903348858e-3  
1/n^(7/10) = 3.98107170553497e-2  
difference = 3.39886980218611e-2  
n = 200 , left side = 2.75417225524133e-3  
1/n^(7/10) = 2.45063709469745e-2  
difference = 2.17521986917332e-2  
n = 500 , left side = 1.06440558786375e-3  
1/n^(7/10) = 1.29039002429643e-2  
difference = 1.18394946551006e-2

$$x^4$$

n = 10 , left side = 1.02540884681400e-1  
1/n^(7/10) = 1.99526231496888e-1  
difference = 9.69853468154883e-2  
n = 20 , left side = 3.49981874860215e-2  
1/n^(7/10) = 1.22822802611579e-1  
difference = 8.78246151255575e-2  
n = 50 , left side = 9.52960631552963e-3  
1/n^(7/10) = 6.46727006577358e-2  
difference = 5.51430943422061e-2  
n = 100 , left side = 4.09764755001933e-3  
1/n^(7/10) = 3.98107170553497e-2

```

difference = 3.57130695053304e-2
n = 200 , left side = 1.88876104704867e-3
1/n^(7/10) = 2.45063709469745e-2
difference = 2.26176098999258e-2
n = 500 , left side = 7.17895958025169e-4
1/n^(7/10) = 1.29039002429643e-2
difference = 1.21860042849392e-2

```

$$x^{10}$$

```

n = 10 , left side = 4.39432749437959e-2
1/n^(7/10) = 1.99526231496888e-1
difference = 1.55582956553092e-1
n = 20 , left side = 5.59881198565935e-3
1/n^(7/10) = 1.22822802611579e-1
difference = 1.17223990625920e-1
n = 50 , left side = 6.58122885628412e-4
1/n^(7/10) = 6.46727006577358e-2
difference = 6.40145777721073e-2
n = 100 , left side = 2.17135216419487e-4
1/n^(7/10) = 3.98107170553497e-2
difference = 3.95935818389302e-2
n = 200 , left side = 8.67799400498142e-5
1/n^(7/10) = 2.45063709469745e-2
difference = 2.44195910069247e-2
n = 500 , left side = 3.00238003037257e-5
1/n^(7/10) = 1.29039002429643e-2
difference = 1.28738764426606e-2

```

-----  
x0 = 1/2, Power = 7/10, lamda = 1, q = 1  
-----

$$x^{\frac{1}{3}}$$

$n = 10$  , left side =  $1.88583358245117e-2$   
 $1/n^{(7/10)} = 1.99526231496888e-1$   
difference =  $1.80667895672376e-1$   
 $n = 20$  , left side =  $3.43036193768773e-3$   
 $1/n^{(7/10)} = 1.22822802611579e-1$   
difference =  $1.19392440673891e-1$   
 $n = 50$  , left side =  $5.15745217625430e-4$   
 $1/n^{(7/10)} = 6.46727006577358e-2$   
difference =  $6.41569554401103e-2$   
 $n = 100$  , left side =  $1.28085535782918e-4$   
 $1/n^{(7/10)} = 3.98107170553497e-2$   
difference =  $3.96826315195668e-2$   
 $n = 200$  , left side =  $3.19697272260777e-5$   
 $1/n^{(7/10)} = 2.45063709469745e-2$   
difference =  $2.44744012197484e-2$   
 $n = 500$  , left side =  $5.11285838611375e-6$   
 $1/n^{(7/10)} = 1.29039002429643e-2$   
difference =  $1.28987873845782e-2$

*x*

$n = 10$  , left side =  $3.03097878388942e-3$   
 $1/n^{(7/10)} = 1.99526231496888e-1$   
difference =  $1.96495252712999e-1$   
 $n = 20$  , left side =  $1.79813965208164e-5$   
 $1/n^{(7/10)} = 1.22822802611579e-1$   
difference =  $1.22804821215058e-1$   
 $n = 50$  , left side =  $5.04973840520506e-12$   
 $1/n^{(7/10)} = 6.46727006577358e-2$   
difference =  $6.46727006526860e-2$   
 $n = 100$  , left side =  $0.0000000000000000e0$   
 $1/n^{(7/10)} = 3.98107170553497e-2$   
difference =  $3.98107170553497e-2$   
 $n = 200$  , left side =  $0.0000000000000000e0$   
 $1/n^{(7/10)} = 2.45063709469745e-2$   
difference =  $2.45063709469745e-2$

n = 500 , left side = 0.0000000000000000e0  
 $1/n^{(7/10)}$  = 1.29039002429643e-2  
 difference = 1.29039002429643e-2

$$x^2$$

n = 10 , left side = 3.13288100022529e-2  
 $1/n^{(7/10)}$  = 1.99526231496888e-1  
 difference = 1.68197421494635e-1  
 n = 20 , left side = 9.02981956494564e-3  
 $1/n^{(7/10)}$  = 1.22822802611579e-1  
 difference = 1.13792983046633e-1  
 n = 50 , left side = 1.44928066358063e-3  
 $1/n^{(7/10)}$  = 6.46727006577358e-2  
 difference = 6.32234199941551e-2  
 n = 100 , left side = 3.62320167826058e-4  
 $1/n^{(7/10)}$  = 3.98107170553497e-2  
 difference = 3.94483968875237e-2  
 n = 200 , left side = 9.05800419564451e-5  
 $1/n^{(7/10)}$  = 2.45063709469745e-2  
 difference = 2.44157909050181e-2  
 n = 500 , left side = 1.44928067127847e-5  
 $1/n^{(7/10)}$  = 1.29039002429643e-2  
 difference = 1.28894074362515e-2

$$x^3$$

n = 10 , left side = 4.78600213916087e-2  
 $1/n^{(7/10)}$  = 1.99526231496888e-1  
 difference = 1.51666210105279e-1  
 n = 20 , left side = 1.35520533206202e-2  
 $1/n^{(7/10)}$  = 1.22822802611579e-1  
 difference = 1.09270749290959e-1  
 n = 50 , left side = 2.17392099772526e-3  
 $1/n^{(7/10)}$  = 6.46727006577358e-2  
 difference = 6.24987796600105e-2

$n = 100$  , left side = 5.43480251739198e-4  
 $1/n^{(7/10)} = 3.98107170553497e-2$   
difference = 3.92672368036105e-2  
 $n = 200$  , left side = 1.35870062934806e-4  
 $1/n^{(7/10)} = 2.45063709469745e-2$   
difference = 2.43705008840397e-2  
 $n = 500$  , left side = 2.17392100697045e-5  
 $1/n^{(7/10)} = 1.29039002429643e-2$   
difference = 1.28821610328946e-2

$$x^4$$

$n = 10$  , left side = 5.14533906505906e-2  
 $1/n^{(7/10)} = 1.99526231496888e-1$   
difference = 1.48072840846297e-1  
 $n = 20$  , left side = 1.38732244570935e-2  
 $1/n^{(7/10)} = 1.22822802611579e-1$   
difference = 1.08949578154486e-1  
 $n = 50$  , left side = 2.18227896612333e-3  
 $1/n^{(7/10)} = 6.46727006577358e-2$   
difference = 6.24904216916124e-2  
 $n = 100$  , left side = 5.44002624822598e-4  
 $1/n^{(7/10)} = 3.98107170553497e-2$   
difference = 3.92667144305271e-2  
 $n = 200$  , left side = 1.35902711252578e-4  
 $1/n^{(7/10)} = 2.45063709469745e-2$   
difference = 2.43704682357219e-2  
 $n = 500$  , left side = 2.17400458665112e-5  
 $1/n^{(7/10)} = 1.29039002429643e-2$   
difference = 1.28821601970978e-2

$$x^{10}$$

$n = 10$  , left side = 2.39574413183784e-2  
 $1/n^{(7/10)} = 1.99526231496888e-1$   
difference = 1.75568790178510e-1

```

n = 20 , left side = 2.97086004062650e-3
          1/n^(7/10) = 1.22822802611579e-1
          difference = 1.19851942570953e-1
n = 50 , left side = 2.83599622557920e-4
          1/n^(7/10) = 6.46727006577358e-2
          difference = 6.43891010351778e-2
n = 100 , left side = 6.54249762593842e-5
          1/n^(7/10) = 3.98107170553497e-2
          difference = 3.97452920790903e-2
n = 200 , left side = 1.60297404173209e-5
          1/n^(7/10) = 2.45063709469745e-2
          difference = 2.44903412065572e-2
n = 500 , left side = 2.55030753033912e-6
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.29013499354340e-2

```

#### 4 Real-valued neural network approximation based on the q-deformed and $\lambda$ -parametrized half hyperbolic tangent - part 2

```

[ ]: RR.scientific_notation(True)
powers = [3/10, 1/2, 7/10]
lamdas = [1/4, 1/2, 1]    #deformation parameter lamda over (0, 1]
    ↪ 1] - these are the beta values in the formula
qs = [1/4, 1/2, 1]    #deformation coefficient

funcs = [sin(x), cos(x)]    #choice of functions
a = -pi    #the interval
b = pi    #the interval
x0s= [pi/4, pi/2, 3*pi/4]

#####
for x0 in x0s:
#####

```



```

    for power in powers:          #going over various powers for 1/
↳  $n^{\text{power}}$ 

        □
↳ #####

        for lamda in lamdas:      #going over each lamda value

            □
↳ #####

            for q in qs:          #going over each q value

                □
↳ #####

                print()
                print()

            □
↳ print("-----

                    print("x0 = " + str(x0)+" , Power = "+
↳ str(power)+ " , lamda = "+ str(lamda) + " , q = " + str(q))

                □
↳ print("-----

                    #the activation function
                    phi(x) = (1-q*(e-lamda*x))/
↳ (1+q*(e-lamda*x))      #formula 20.1

                    #q-deformed and  $\beta$ -parametrized half hyperbolic
↳ tangent

                    theta(x) = 1/4*(phi(x+1) - phi(x-1))    □
↳ #formula 20.8

                □
↳ #####

                for i in range(len(funcs)):

                    □
↳ #####

                    f(x)=funcs[i]
                    show(f(x))
                    for n in [2000, 5000]:

```

```

def H(n, f, x):    #real-valued
    # linear neural network operators
    # return sum(f(k/n)*theta(n*x-k)
    for k in [ceil(n*a),...,floor(n*b)])/sum(theta(n*x-k) for k
    in [ceil(n*a),...,floor(n*b)])
    #leftSide = abs(H(n,f,x0)-f(x0))
    leftSide = abs(sum(f(k/
    n)*theta(n*x0-k) for k in [ceil(n*a),...,floor(n*b)])/
    sum(theta(n*x0-k) for k in [ceil(n*a),...,floor(n*b)]) -
    f(x0))

    val1 = n
    val2 = leftSide.n()
    val3 = 1/(n^power).n()
    print("          n = "+str(val1), ",
    left side = "+str(val2), "\n          1/
    n^("+str(power)+") = "+str(val3), "\n
    difference = "+str(val3-val2))

```

---

$x_0 = 1/4\pi$ ,  $\text{Power} = 3/10$ ,  $\text{lamda} = 1/4$ ,  $q = 1/4$

---

$\sin(x)$

```

n = 2000 , left side = 1.95310094358758e-3
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.00303417312770e-1
n = 5000 , left side = 7.83021541616469e-4
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.68969394299569e-2

```

$\cos(x)$

```

n = 2000 , left side = 1.96790064404651e-3
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.00288617612311e-1
n = 5000 , left side = 7.85389504806777e-4
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.68945714667666e-2

```

---

```

x0 = 1/4*pi, Power = 3/10, lamda = 1/4,  q = 1/2

```

---

$\sin(x)$

```

n = 2000 , left side = 9.74889862984551e-4
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.01281628393373e-1
n = 5000 , left side = 3.91244982227645e-4
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.72887159893457e-2

```

$\cos(x)$

```

n = 2000 , left side = 9.85612814691228e-4
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.01270905441666e-1
n = 5000 , left side = 3.92960661552144e-4
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.72870003100212e-2

```

---

```

x0 = 1/4*pi, Power = 3/10, lamda = 1/4,  q = 1

```

---

$\sin(x)$

```

n = 2000 , left side = 4.68201729342255e-6
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.02251836239064e-1
n = 5000 , left side = 7.49125671828388e-7
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.76792118459016e-2

```

$\cos(x)$

```

n = 2000 , left side = 4.68201729242335e-6
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.02251836239065e-1
n = 5000 , left side = 7.49125673271678e-7
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.76792118459001e-2

```

-----  
 $x_0 = 1/4\pi$ , Power = 3/10, lamda = 1/2, q = 1/4  
 -----

$\sin(x)$

```

n = 2000 , left side = 9.78384108846764e-4
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.01278134147511e-1
n = 5000 , left side = 3.91803600351071e-4
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.72881573712223e-2

```

$\cos(x)$

```

n = 2000 , left side = 9.82128243529834e-4
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.01274390012827e-1
n = 5000 , left side = 3.92402662611313e-4
          1/n^(3/10) = 7.76799609715734e-2

```

difference = 7.72875583089621e-2

-----  
x0 = 1/4\*pi, Power = 3/10, lamda = 1/2, q = 1/2  
-----

$\sin(x)$

n = 2000 , left side = 4.88765734908858e-4  
1/n^(3/10) = 1.02256518256357e-1  
difference = 1.01767752521448e-1  
n = 5000 , left side = 1.95833577701698e-4  
1/n^(3/10) = 7.76799609715734e-2  
difference = 7.74841273938717e-2

$\cos(x)$

n = 2000 , left side = 4.91490676762685e-4  
1/n^(3/10) = 1.02256518256357e-1  
difference = 1.01765027579595e-1  
n = 5000 , left side = 1.96269568850549e-4  
1/n^(3/10) = 7.76799609715734e-2  
difference = 7.74836914027228e-2

-----  
x0 = 1/4\*pi, Power = 3/10, lamda = 1/2, q = 1  
-----

$\sin(x)$

n = 2000 , left side = 1.19260542830180e-6  
1/n^(3/10) = 1.02256518256357e-1  
difference = 1.02255325650929e-1  
n = 5000 , left side = 1.90817055156778e-7

$1/n^{(3/10)} = 7.76799609715734e-2$   
difference = 7.76797701545182e-2

$\cos(x)$

n = 2000 , left side = 1.19260542752464e-6  
 $1/n^{(3/10)} = 1.02256518256357e-1$   
difference = 1.02255325650930e-1  
n = 5000 , left side = 1.90817054823711e-7  
 $1/n^{(3/10)} = 7.76799609715734e-2$   
difference = 7.76797701545186e-2

---

x0 = 1/4\*pi, Power = 3/10, lamda = 1, q = 1/4

---

$\sin(x)$

n = 2000 , left side = 4.89638706925533e-4  
 $1/n^{(3/10)} = 1.02256518256357e-1$   
difference = 1.01766879549432e-1  
n = 5000 , left side = 1.95973196963295e-4  
 $1/n^{(3/10)} = 7.76799609715734e-2$   
difference = 7.74839877746101e-2

$\cos(x)$

n = 2000 , left side = 4.90618935762188e-4  
 $1/n^{(3/10)} = 1.02256518256357e-1$   
difference = 1.01765899320595e-1  
n = 5000 , left side = 1.96130033619957e-4  
 $1/n^{(3/10)} = 7.76799609715734e-2$   
difference = 7.74838309379534e-2

---

x0 = 1/4\*pi, Power = 3/10, lamda = 1, q = 1/2

---

$\sin(x)$

n = 2000 , left side = 2.44701705652606e-4  
1/n^(3/10) = 1.02256518256357e-1  
difference = 1.02011816550705e-1  
n = 5000 , left side = 9.79677681436364e-5  
1/n^(3/10) = 7.76799609715734e-2  
difference = 7.75819932034297e-2

$\cos(x)$

n = 2000 , left side = 2.45427135861620e-4  
1/n^(3/10) = 1.02256518256357e-1  
difference = 1.02011091120496e-1  
n = 5000 , left side = 9.80838370117088e-5  
1/n^(3/10) = 7.76799609715734e-2  
difference = 7.75818771345617e-2

---

x0 = 1/4\*pi, Power = 3/10, lamda = 1, q = 1

---

$\sin(x)$

n = 2000 , left side = 3.20260086117408e-7  
1/n^(3/10) = 1.02256518256357e-1  
difference = 1.02256197996271e-1  
n = 5000 , left side = 5.12400826213621e-8  
1/n^(3/10) = 7.76799609715734e-2  
difference = 7.76799097314908e-2

$\cos(x)$

```

n = 2000 , left side = 3.20237313777838e-7
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.02256198019044e-1
n = 5000 , left side = 5.12395328389204e-8
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.76799097320405e-2

```

---

```

x0 = 1/4*pi, Power = 1/2, lamda = 1/4,  q = 1/4

```

---

$\sin(x)$

```

n = 2000 , left side = 1.95310094358758e-3
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.04075788314103e-2
n = 5000 , left side = 7.83021541616469e-4
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.33591140821145e-2

```

$\cos(x)$

```

n = 2000 , left side = 1.96790064404651e-3
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.03927791309514e-2
n = 5000 , left side = 7.85389504806777e-4
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.33567461189242e-2

```

---

```

x0 = 1/4*pi, Power = 1/2, lamda = 1/4,  q = 1/2

```

---

$\sin(x)$



```

n = 2000 , left side = 9.74889862984551e-4
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.13857899120133e-2
n = 5000 , left side = 3.91244982227645e-4
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.37508906415033e-2

```

$\cos(x)$

```

n = 2000 , left side = 9.85612814691228e-4
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.13750669603067e-2
n = 5000 , left side = 3.92960661552144e-4
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.37491749621788e-2

```

-----  
 $x_0 = 1/4\pi$ , Power = 1/2, lamda = 1/4, q = 1  
 -----

$\sin(x)$

```

n = 2000 , left side = 4.68201729342255e-6
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.23559977577045e-2
n = 5000 , left side = 7.49125671828388e-7
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.41413864980591e-2

```

$\cos(x)$

```

n = 2000 , left side = 4.68201729242335e-6
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.23559977577055e-2
n = 5000 , left side = 7.49125673271678e-7
          1/n^(1/2) = 1.41421356237310e-2

```

difference = 1.41413864980577e-2

-----  
x0 = 1/4\*pi, Power = 1/2, lamda = 1/2, q = 1/4  
-----

$\sin(x)$

n = 2000 , left side = 9.78384108846764e-4  
1/n^(1/2) = 2.23606797749979e-2  
difference = 2.13822956661511e-2  
n = 5000 , left side = 3.91803600351071e-4  
1/n^(1/2) = 1.41421356237310e-2  
difference = 1.37503320233799e-2

$\cos(x)$

n = 2000 , left side = 9.82128243529834e-4  
1/n^(1/2) = 2.23606797749979e-2  
difference = 2.13785515314681e-2  
n = 5000 , left side = 3.92402662611313e-4  
1/n^(1/2) = 1.41421356237310e-2  
difference = 1.37497329611196e-2

-----  
x0 = 1/4\*pi, Power = 1/2, lamda = 1/2, q = 1/2  
-----

$\sin(x)$

n = 2000 , left side = 4.88765734908858e-4  
1/n^(1/2) = 2.23606797749979e-2  
difference = 2.18719140400890e-2  
n = 5000 , left side = 1.95833577701698e-4

$1/n^{(1/2)} = 1.41421356237310e-2$   
difference = 1.39463020460293e-2

$\cos(x)$

n = 2000 , left side = 4.91490676762685e-4  
 $1/n^{(1/2)} = 2.23606797749979e-2$   
difference = 2.18691890982352e-2  
n = 5000 , left side = 1.96269568850549e-4  
 $1/n^{(1/2)} = 1.41421356237310e-2$   
difference = 1.39458660548804e-2

-----  
x0 = 1/4\*pi, Power = 1/2, lamda = 1/2, q = 1  
-----

$\sin(x)$

n = 2000 , left side = 1.19260542830180e-6  
 $1/n^{(1/2)} = 2.23606797749979e-2$   
difference = 2.23594871695696e-2  
n = 5000 , left side = 1.90817055156778e-7  
 $1/n^{(1/2)} = 1.41421356237310e-2$   
difference = 1.41419448066758e-2

$\cos(x)$

n = 2000 , left side = 1.19260542752464e-6  
 $1/n^{(1/2)} = 2.23606797749979e-2$   
difference = 2.23594871695704e-2  
n = 5000 , left side = 1.90817054823711e-7  
 $1/n^{(1/2)} = 1.41421356237310e-2$   
difference = 1.41419448066761e-2  
-----

$x_0 = 1/4\pi$ , Power = 1/2, lamda = 1, q = 1/4

---

$\sin(x)$

n = 2000 , left side = 4.89638706925533e-4  
1/n<sup>(1/2)</sup> = 2.23606797749979e-2  
difference = 2.18710410680724e-2  
n = 5000 , left side = 1.95973196963295e-4  
1/n<sup>(1/2)</sup> = 1.41421356237310e-2  
difference = 1.39461624267677e-2

$\cos(x)$

n = 2000 , left side = 4.90618935762188e-4  
1/n<sup>(1/2)</sup> = 2.23606797749979e-2  
difference = 2.18700608392357e-2  
n = 5000 , left side = 1.96130033619957e-4  
1/n<sup>(1/2)</sup> = 1.41421356237310e-2  
difference = 1.39460055901110e-2

---

$x_0 = 1/4\pi$ , Power = 1/2, lamda = 1, q = 1/2

---

$\sin(x)$

n = 2000 , left side = 2.44701705652606e-4  
1/n<sup>(1/2)</sup> = 2.23606797749979e-2  
difference = 2.21159780693453e-2

```
[ ]: RR.scientific_notation(True)
powers = [3/10, 1/2, 7/10]
lamdas = [1/4, 1/2, 1]    #deformation parameter lamda over (0, 1]
                             ↪ 1] - these are the beta values in the formula
```

```

qs = [1/4, 1/2, 1]  #deformation coefficient

funcs = [x^(1/3), x, x^2, x^3, x^4, x^10]  #choice of
↳ functions
a = -1    #the interval
b = 1     #the interval
x0=1/2

for power in powers:
    ↳
    ↳ #####
    for lamda in lamdas:  #going over each lamda value
        ↳
        ↳ #####
        for q in qs:      #going over each q value
            ↳
            ↳ #####
            print()
            print()
            ↳
            ↳ print("-----")
                print("x0 = " + str(x0)+", Power = "+ str(power)+
            ↳ ", lamda = "+ str(lamda) + ", q = " + str(q))
            ↳
            ↳ print("-----")
                #the activation function
                phi(x) = (1-q*(e^(-lamda*x)))/(1+q*(e^(-lamda*x)))
            ↳ #formula 20.1

                #q-deformed and  $\beta$ -parametrized half hyperbolic
            ↳ tangent
                theta(x) = 1/4*(phi(x+1) - phi(x-1))    #formula
            ↳ 20.8

```

```

    □
    ↪#####
        for i in range(len(funcs)):
            □
            ↪#####
                f(x)=funcs[i]
                show(f(x))
                for n in [2000, 5000]:
                    #def H(n, f, x):      #real-valued linear
                    ↪neural network operators
                        #      return sum(f(k/n)*theta(n*x-k) for k
                    ↪in [ceil(n*a),...,floor(n*b)])/sum(theta(n*x-k) for k in
                    ↪[ceil(n*a),...,floor(n*b)])
                        #leftSide = abs(H(n,f,x0)-f(x0))
                        leftSide = abs(sum(f(k/n)*theta(n*x0-k)
                    ↪for k in [ceil(n*a),...,floor(n*b)])/sum(theta(n*x0-k) for k
                    ↪in [ceil(n*a),...,floor(n*b)]) - f(x0))

                        val1 = n
                        val2 = leftSide.n()
                        val3 = 1/(n^power).n()
                        print("          n = "+str(val1), ", left
                    ↪side = "+str(val2), " \n          1/
                    ↪n^("+str(power)+") = "+str(val3), " \n
                    ↪difference = "+str(val3-val2))

```

---

x0 = 1/2, Power = 3/10, lamda = 1/4, q = 1/4

---

$$x^{\frac{1}{3}}$$

n = 2000 , left side = 1.45973769075280e-3  
 1/n^(3/10) = 1.02256518256357e-1

```

        difference = 1.00796780565605e-1
n = 5000 , left side = 5.85650001354687e-4
        1/n^(3/10) = 7.76799609715734e-2
        difference = 7.70943109702187e-2

```

$x$

```

n = 2000 , left side = 2.77258872223973e-3
        1/n^(3/10) = 1.02256518256357e-1
        difference = 9.94839295341176e-2
n = 5000 , left side = 1.10903548889585e-3
        1/n^(3/10) = 7.76799609715734e-2
        difference = 7.65709254826775e-2

```

$x^2$

```

n = 2000 , left side = 2.79351877633044e-3
        1/n^(3/10) = 1.02256518256357e-1
        difference = 9.94629994800269e-2
n = 5000 , left side = 1.11238429755101e-3
        1/n^(3/10) = 7.76799609715734e-2
        difference = 7.65675766740224e-2

```

$x^3$

```

n = 2000 , left side = 2.11096808695638e-3
        1/n^(3/10) = 1.02256518256357e-1
        difference = 1.00145550169401e-1
n = 5000 , left side = 8.36808243358689e-4
        1/n^(3/10) = 7.76799609715734e-2
        difference = 7.68431527282147e-2

```

$x^4$

```

n = 2000 , left side = 1.41795377434802e-3
        1/n^(3/10) = 1.02256518256357e-1
        difference = 1.00838564482009e-1

```

```

n = 5000 , left side = 5.59557820777254e-4
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.71204031507961e-2

```

$$x^{10}$$

```

n = 2000 , left side = 5.79591945905002e-5
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.02198559061767e-1
n = 5000 , left side = 2.22575140037271e-5
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.76577034575697e-2

```

-----  
x0 = 1/2, Power = 3/10, lamda = 1/4, q = 1/2  
-----

$$x^{\frac{1}{3}}$$

```

n = 2000 , left side = 7.28207805430148e-4
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.01528310450927e-1
n = 5000 , left side = 2.92559548393356e-4
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.73874014231800e-2

```

$$x$$

```

n = 2000 , left side = 1.38629436112003e-3
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.00870223895237e-1
n = 5000 , left side = 5.545177444448035e-4
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.71254432271253e-2

```



$$x^2$$

```

n = 2000 , left side = 1.40145897904348e-3
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.00855059277314e-1
n = 5000 , left side = 5.56944083316024e-4
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.71230168882574e-2

```

$$x^3$$

```

n = 2000 , left side = 1.06252543720417e-3
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.01193992819153e-1
n = 5000 , left side = 4.19531511964305e-4
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.72604294596091e-2

```

$$x^4$$

```

n = 2000 , left side = 7.16010476710327e-4
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.01540507779647e-1
n = 5000 , left side = 2.80905793970901e-4
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.73990551776025e-2

```

$$x^{10}$$

```

n = 2000 , left side = 2.97988137052012e-5
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.02226719442652e-1
n = 5000 , left side = 1.12604691755727e-5
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.76687005023978e-2

```

-----  
x0 = 1/2, Power = 3/10, lamda = 1/4, q = 1  
-----

$$x^{\frac{1}{3}}$$

n = 2000 , left side = 4.67186009045495e-6  
1/n^(3/10) = 1.02256518256357e-1  
difference = 1.02251846396267e-1  
n = 5000 , left side = 7.47446048499079e-7  
1/n^(3/10) = 7.76799609715734e-2  
difference = 7.76792135255249e-2

$$x$$

n = 2000 , left side = 0.0000000000000000e0  
1/n^(3/10) = 1.02256518256357e-1  
difference = 1.02256518256357e-1  
n = 5000 , left side = 0.0000000000000000e0  
1/n^(3/10) = 7.76799609715734e-2  
difference = 7.76799609715734e-2

$$x^2$$

n = 2000 , left side = 1.32428058677303e-5  
1/n^(3/10) = 1.02256518256357e-1  
difference = 1.02243275450490e-1  
n = 5000 , left side = 2.11884893858150e-6  
1/n^(3/10) = 7.76799609715734e-2  
difference = 7.76778421226348e-2

$$x^3$$

n = 2000 , left side = 1.98642088022338e-5  
1/n^(3/10) = 1.02256518256357e-1  
difference = 1.02236654047555e-1  
n = 5000 , left side = 3.17827340845511e-6

1/n^(3/10) = 7.76799609715734e-2  
 difference = 7.76767826981649e-2

$$x^4$$

n = 2000 , left side = 1.98649427157888e-5  
 1/n^(3/10) = 1.02256518256357e-1  
 difference = 1.02236653313642e-1  
 n = 5000 , left side = 3.17829219639854e-6  
 1/n^(3/10) = 7.76799609715734e-2  
 difference = 7.76767826793770e-2

$$x^{10}$$

n = 2000 , left side = 2.33024632642588e-6  
 1/n^(3/10) = 1.02256518256357e-1  
 difference = 1.02254188010031e-1  
 n = 5000 , left side = 3.72515568407197e-7  
 1/n^(3/10) = 7.76799609715734e-2  
 difference = 7.76795884560050e-2

-----  
 x0 = 1/2, Power = 3/10, lamda = 1/2, q = 1/4  
 -----

$$x^{\frac{1}{3}}$$

n = 2000 , left side = 7.31673691973578e-4  
 1/n^(3/10) = 1.02256518256357e-1  
 difference = 1.01524844564384e-1  
 n = 5000 , left side = 2.93115579032444e-4  
 1/n^(3/10) = 7.76799609715734e-2  
 difference = 7.73868453925409e-2

$$x$$

```

n = 2000 , left side = 1.38629436111992e-3
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.00870223895237e-1
n = 5000 , left side = 5.54517744448035e-4
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.71254432271253e-2

```

$$x^2$$

```

n = 2000 , left side = 1.39158937464245e-3
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.00864928881715e-1
n = 5000 , left side = 5.55364946611514e-4
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.71245960249619e-2

```

$$x^3$$

```

n = 2000 , left side = 1.04767998407174e-3
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.01208838272286e-1
n = 5000 , left side = 4.17160179930126e-4
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.72628007916433e-2

```

$$x^4$$

```

n = 2000 , left side = 7.01123176443719e-4
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.01555395079914e-1
n = 5000 , left side = 2.78531814463245e-4
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.74014291571101e-2

```

$$x^{10}$$

```

n = 2000 , left side = 2.80227731769833e-5
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.02228495483180e-1
n = 5000 , left side = 1.09803560975753e-5
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.76689806154758e-2

```

-----  
x0 = 1/2, Power = 3/10, lamda = 1/2, q = 1/2  
-----

$$x^{\frac{1}{3}}$$

```

n = 2000 , left side = 3.65410972395175e-4
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.01891107283962e-1
n = 5000 , left side = 1.46489688196749e-4
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.75334712833766e-2

```

$$x$$

```

n = 2000 , left side = 6.93147180560016e-4
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.01563371075797e-1
n = 5000 , left side = 2.77258872223851e-4
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.74027020993495e-2

```

$$x^2$$

```

n = 2000 , left side = 6.97000835040928e-4
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.01559517421316e-1
n = 5000 , left side = 2.77875456940913e-4

```

1/n^(3/10) = 7.76799609715734e-2  
 difference = 7.74020855146325e-2

$$x^3$$

n = 2000 , left side = 5.25648214541374e-4  
 1/n^(3/10) = 1.02256518256357e-1  
 difference = 1.01730870041816e-1  
 n = 5000 , left side = 2.08869501476971e-4  
 1/n^(3/10) = 7.76799609715734e-2  
 difference = 7.74710914700964e-2

$$x^4$$

n = 2000 , left side = 3.52368823871019e-4  
 1/n^(3/10) = 1.02256518256357e-1  
 difference = 1.01904149432486e-1  
 n = 5000 , left side = 1.39555255115609e-4  
 1/n^(3/10) = 7.76799609715734e-2  
 difference = 7.75404057164578e-2

$$x^{10}$$

n = 2000 , left side = 1.42225079194571e-5  
 1/n^(3/10) = 1.02256518256357e-1  
 difference = 1.02242295748438e-1  
 n = 5000 , left side = 5.52404203239387e-6  
 1/n^(3/10) = 7.76799609715734e-2  
 difference = 7.76744369295410e-2

-----  
 x0 = 1/2, Power = 3/10, lamda = 1/2, q = 1  
 -----

$$x^{\frac{1}{3}}$$

```

n = 2000 , left side = 1.18994097009217e-6
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.02255328315387e-1
n = 5000 , left side = 1.90387244969337e-7
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.76797705843284e-2

```

$x$

```

n = 2000 , left side = 1.11022302462516e-16
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.02256518256357e-1
n = 5000 , left side = 0.0000000000000000e0
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.76799609715734e-2

```

$x^2$

```

n = 2000 , left side = 3.37320146703846e-6
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.02253145054890e-1
n = 5000 , left side = 5.39712234737255e-7
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.76794212593386e-2

```

$x^3$

```

n = 2000 , left side = 5.05980220058544e-6
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.02251458454157e-1
n = 5000 , left side = 8.09568352105883e-7
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.76791514032213e-2

```

$x^4$

```

n = 2000 , left side = 5.05984931555015e-6
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.02251458407042e-1
n = 5000 , left side = 8.09569558168910e-7
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.76791514020152e-2

```

$$x^{10}$$

```

n = 2000 , left side = 5.93100185746322e-7
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.02255925156172e-1
n = 5000 , left side = 9.48752487690396e-8
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.76798660963246e-2

```

-----  
x0 = 1/2, Power = 3/10, lamda = 1, q = 1/4  
-----

$$x^{\frac{1}{3}}$$

```

n = 2000 , left side = 3.66279383739010e-4
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.01890238872618e-1
n = 5000 , left side = 1.46628824906569e-4
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.75333321466668e-2

```

$$x$$

```

n = 2000 , left side = 6.93147191573207e-4
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.01563371064784e-1
n = 5000 , left side = 2.77258876629438e-4

```



$1/n^{(3/10)} = 7.76799609715734e-2$   
difference = 7.74027020949439e-2

$x^2$

n = 2000 , left side = 6.94533444929368e-4  
 $1/n^{(3/10)} = 1.02256518256357e-1$   
difference = 1.01561984811428e-1  
n = 5000 , left side = 2.77480677166320e-4  
 $1/n^{(3/10)} = 7.76799609715734e-2$   
difference = 7.74024802944071e-2

$x^3$

n = 2000 , left side = 5.21941990297453e-4  
 $1/n^{(3/10)} = 1.02256518256357e-1$   
difference = 1.01734576266060e-1  
n = 5000 , left side = 2.08277000138812e-4  
 $1/n^{(3/10)} = 7.76799609715734e-2$   
difference = 7.74716839714346e-2

$x^4$

n = 2000 , left side = 3.48657415094475e-4  
 $1/n^{(3/10)} = 1.02256518256357e-1$   
difference = 1.01907860841263e-1  
n = 5000 , left side = 1.38962422999142e-4  
 $1/n^{(3/10)} = 7.76799609715734e-2$   
difference = 7.75409985485742e-2

$x^{10}$

n = 2000 , left side = 1.37838066332147e-5  
 $1/n^{(3/10)} = 1.02256518256357e-1$   
difference = 1.02242734449724e-1  
n = 5000 , left side = 5.45433431815541e-6  
 $1/n^{(3/10)} = 7.76799609715734e-2$

difference = 7.76745066372552e-2

-----  
x0 = 1/2, Power = 3/10, lamda = 1, q = 1/2  
-----

$x^{\frac{1}{3}}$

n = 2000 , left side = 1.83022238704367e-4  
1/n^(3/10) = 1.02256518256357e-1  
difference = 1.02073496017653e-1  
n = 5000 , left side = 7.32956220087511e-5  
1/n^(3/10) = 7.76799609715734e-2  
difference = 7.76066653495646e-2

$x$

n = 2000 , left side = 3.46573574531495e-4  
1/n^(3/10) = 1.02256518256357e-1  
difference = 1.01909944681826e-1  
n = 5000 , left side = 1.38629429812687e-4  
1/n^(3/10) = 7.76799609715734e-2  
difference = 7.75413315417607e-2

$x^2$

n = 2000 , left side = 3.47599488122630e-4  
1/n^(3/10) = 1.02256518256357e-1  
difference = 1.01908918768235e-1  
n = 5000 , left side = 1.38793575987228e-4  
1/n^(3/10) = 7.76799609715734e-2  
difference = 7.75411673955862e-2

$x^3$

```

n = 2000 , left side = 2.61470034692929e-4
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.01995048221664e-1
n = 5000 , left side = 1.04218354559399e-4
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.75757426170140e-2

```

$$x^4$$

```

n = 2000 , left side = 1.74827628399418e-4
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.02081690627958e-1
n = 5000 , left side = 6.95610601449959e-5
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.76103999114284e-2

```

$$x^{10}$$

```

n = 2000 , left side = 6.95028639556713e-6
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.02249567969962e-1
n = 5000 , left side = 2.73651920556519e-6
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.76772244523678e-2

```

-----  
x0 = 1/2, Power = 3/10, lamda = 1, q = 1  
-----

$$x^{\frac{1}{3}}$$

```

n = 2000 , left side = 3.19528047798556e-7
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.02256198728310e-1
n = 5000 , left side = 5.11242584932958e-8

```

```

1/n^(3/10) = 7.76799609715734e-2
difference = 7.76799098473149e-2

```

$x$

```

n = 2000 , left side = 0.0000000000000000e0
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.02256518256357e-1
n = 5000 , left side = 0.0000000000000000e0
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.76799609715734e-2

```

$x^2$

```

n = 2000 , left side = 9.05800419392921e-7
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.02255612455938e-1
n = 5000 , left side = 1.44928067158379e-7
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.76798160435062e-2

```

$x^3$

```

n = 2000 , left side = 1.35870062942245e-6
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.02255159555728e-1
n = 5000 , left side = 2.17392100737568e-7
          1/n^(3/10) = 7.76799609715734e-2
          difference = 7.76797435794726e-2

```

$x^4$

```

n = 2000 , left side = 1.35870389404713e-6
          1/n^(3/10) = 1.02256518256357e-1
          difference = 1.02255159552463e-1
n = 5000 , left side = 2.17392184295728e-7

```

$1/n^{(3/10)} = 7.76799609715734e-2$   
 difference = 7.76797435793891e-2

$$x^{10}$$

n = 2000 , left side = 1.59233443336286e-7  
 $1/n^{(3/10)} = 1.02256518256357e-1$   
 difference = 1.02256359022914e-1  
 n = 5000 , left side = 2.54759102073614e-8  
 $1/n^{(3/10)} = 7.76799609715734e-2$   
 difference = 7.76799354956632e-2

-----  
 x0 = 1/2, Power = 1/2, lamda = 1/4, q = 1/4  
 -----

$$x^{\frac{1}{3}}$$

n = 2000 , left side = 1.45973769075280e-3  
 $1/n^{(1/2)} = 2.23606797749979e-2$   
 difference = 2.09009420842451e-2  
 n = 5000 , left side = 5.85650001354687e-4  
 $1/n^{(1/2)} = 1.41421356237310e-2$   
 difference = 1.35564856223763e-2

$$x$$

n = 2000 , left side = 2.77258872223973e-3  
 $1/n^{(1/2)} = 2.23606797749979e-2$   
 difference = 1.95880910527582e-2  
 n = 5000 , left side = 1.10903548889585e-3  
 $1/n^{(1/2)} = 1.41421356237310e-2$   
 difference = 1.30331001348351e-2

$$x^2$$

```

n = 2000 , left side = 2.79351877633044e-3
          1/n^(1/2) = 2.23606797749979e-2
          difference = 1.95671609986675e-2
n = 5000 , left side = 1.11238429755101e-3
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.30297513261799e-2

```

$$x^3$$

```

n = 2000 , left side = 2.11096808695638e-3
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.02497116880415e-2
n = 5000 , left side = 8.36808243358689e-4
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.33053273803723e-2

```

$$x^4$$

```

n = 2000 , left side = 1.41795377434802e-3
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.09427260006499e-2
n = 5000 , left side = 5.59557820777254e-4
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.35825778029537e-2

```

$$x^{10}$$

```

n = 2000 , left side = 5.79591945905002e-5
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.23027205804074e-2
n = 5000 , left side = 2.22575140037271e-5
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.41198781097272e-2

```

-----

x0 = 1/2, Power = 1/2, lamda = 1/4, q = 1/2

---

$$x^{\frac{1}{3}}$$

n = 2000 , left side = 7.28207805430148e-4  
1/n^(1/2) = 2.23606797749979e-2  
difference = 2.16324719695677e-2  
n = 5000 , left side = 2.92559548393356e-4  
1/n^(1/2) = 1.41421356237310e-2  
difference = 1.38495760753376e-2

$$x$$

n = 2000 , left side = 1.38629436112003e-3  
1/n^(1/2) = 2.23606797749979e-2  
difference = 2.09743854138779e-2  
n = 5000 , left side = 5.54517744448035e-4  
1/n^(1/2) = 1.41421356237310e-2  
difference = 1.35876178792829e-2

$$x^2$$

n = 2000 , left side = 1.40145897904348e-3  
1/n^(1/2) = 2.23606797749979e-2  
difference = 2.09592207959544e-2  
n = 5000 , left side = 5.56944083316024e-4  
1/n^(1/2) = 1.41421356237310e-2  
difference = 1.35851915404149e-2

$$x^3$$

n = 2000 , left side = 1.06252543720417e-3  
1/n^(1/2) = 2.23606797749979e-2  
difference = 2.12981543377937e-2  
n = 5000 , left side = 4.19531511964305e-4

$1/n^{(1/2)} = 1.41421356237310e-2$   
 difference = 1.37226041117666e-2

$$x^4$$

n = 2000 , left side = 7.16010476710327e-4  
 $1/n^{(1/2)} = 2.23606797749979e-2$   
 difference = 2.16446692982876e-2  
 n = 5000 , left side = 2.80905793970901e-4  
 $1/n^{(1/2)} = 1.41421356237310e-2$   
 difference = 1.38612298297600e-2

$$x^{10}$$

n = 2000 , left side = 2.97988137052012e-5  
 $1/n^{(1/2)} = 2.23606797749979e-2$   
 difference = 2.23308809612927e-2  
 n = 5000 , left side = 1.12604691755727e-5  
 $1/n^{(1/2)} = 1.41421356237310e-2$   
 difference = 1.41308751545554e-2

-----  
 $x_0 = 1/2$ , Power = 1/2, lamda = 1/4, q = 1  
 -----

$$x^{\frac{1}{3}}$$

n = 2000 , left side = 4.67186009045495e-6  
 $1/n^{(1/2)} = 2.23606797749979e-2$   
 difference = 2.23560079149074e-2  
 n = 5000 , left side = 7.47446048499079e-7  
 $1/n^{(1/2)} = 1.41421356237310e-2$   
 difference = 1.41413881776825e-2

$$x$$



```

n = 2000 , left side = 0.0000000000000000e0
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.23606797749979e-2
n = 5000 , left side = 0.0000000000000000e0
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.41421356237310e-2

```

$$x^2$$

```

n = 2000 , left side = 1.32428058677303e-5
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.23474369691302e-2
n = 5000 , left side = 2.11884893858150e-6
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.41400167747924e-2

```

$$x^3$$

```

n = 2000 , left side = 1.98642088022338e-5
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.23408155661957e-2
n = 5000 , left side = 3.17827340845511e-6
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.41389573503225e-2

```

$$x^4$$

```

n = 2000 , left side = 1.98649427157888e-5
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.23408148322821e-2
n = 5000 , left side = 3.17829219639854e-6
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.41389573315346e-2

```

$$x^{10}$$

```

n = 2000 , left side = 2.33024632642588e-6
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.23583495286715e-2
n = 5000 , left side = 3.72515568407197e-7
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.41417631081625e-2

```

-----  
x0 = 1/2, Power = 1/2, lamda = 1/2, q = 1/4  
-----

$$x^{\frac{1}{3}}$$

```

n = 2000 , left side = 7.31673691973578e-4
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.16290060830243e-2
n = 5000 , left side = 2.93115579032444e-4
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.38490200446985e-2

```

$$x$$

```

n = 2000 , left side = 1.38629436111992e-3
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.09743854138780e-2
n = 5000 , left side = 5.54517744448035e-4
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.35876178792829e-2

```

$$x^2$$

```

n = 2000 , left side = 1.39158937464245e-3
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.09690904003554e-2
n = 5000 , left side = 5.55364946611514e-4

```

$1/n^{(1/2)} = 1.41421356237310e-2$   
 difference = 1.35867706771194e-2

$$x^3$$

n = 2000 , left side = 1.04767998407174e-3  
 $1/n^{(1/2)} = 2.23606797749979e-2$   
 difference = 2.13129997909262e-2  
 n = 5000 , left side = 4.17160179930126e-4  
 $1/n^{(1/2)} = 1.41421356237310e-2$   
 difference = 1.37249754438008e-2

$$x^4$$

n = 2000 , left side = 7.01123176443719e-4  
 $1/n^{(1/2)} = 2.23606797749979e-2$   
 difference = 2.16595565985542e-2  
 n = 5000 , left side = 2.78531814463245e-4  
 $1/n^{(1/2)} = 1.41421356237310e-2$   
 difference = 1.38636038092677e-2

$$x^{10}$$

n = 2000 , left side = 2.80227731769833e-5  
 $1/n^{(1/2)} = 2.23606797749979e-2$   
 difference = 2.23326570018209e-2  
 n = 5000 , left side = 1.09803560975753e-5  
 $1/n^{(1/2)} = 1.41421356237310e-2$   
 difference = 1.41311552676334e-2

-----  
 x0 = 1/2, Power = 1/2, lamda = 1/2, q = 1/2  
 -----

$$x^{\frac{1}{3}}$$

```

n = 2000 , left side = 3.65410972395175e-4
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.19952688026027e-2
n = 5000 , left side = 1.46489688196749e-4
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.39956459355342e-2

```

$x$

```

n = 2000 , left side = 6.93147180560016e-4
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.16675325944379e-2
n = 5000 , left side = 2.77258872223851e-4
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.38648767515071e-2

```

$x^2$

```

n = 2000 , left side = 6.97000835040928e-4
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.16636789399570e-2
n = 5000 , left side = 2.77875456940913e-4
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.38642601667900e-2

```

$x^3$

```

n = 2000 , left side = 5.25648214541374e-4
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.18350315604565e-2
n = 5000 , left side = 2.08869501476971e-4
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.39332661222540e-2

```

$x^4$

```

n = 2000 , left side = 3.52368823871019e-4
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.20083109511269e-2
n = 5000 , left side = 1.39555255115609e-4
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.40025803686153e-2

```

$$x^{10}$$

```

n = 2000 , left side = 1.42225079194571e-5
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.23464572670784e-2
n = 5000 , left side = 5.52404203239387e-6
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.41366115816986e-2

```

-----  
x0 = 1/2, Power = 1/2, lamda = 1/2, q = 1  
-----

$$x^{\frac{1}{3}}$$

```

n = 2000 , left side = 1.18994097009217e-6
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.23594898340278e-2
n = 5000 , left side = 1.90387244969337e-7
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.41419452364860e-2

```

$$x$$

```

n = 2000 , left side = 1.11022302462516e-16
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.23606797749978e-2
n = 5000 , left side = 0.000000000000000e0

```

$1/n^{(1/2)} = 1.41421356237310e-2$   
 $\text{difference} = 1.41421356237310e-2$

$$x^2$$

$n = 2000$  , left side =  $3.37320146703846e-6$   
 $1/n^{(1/2)} = 2.23606797749979e-2$   
 $\text{difference} = 2.23573065735309e-2$   
 $n = 5000$  , left side =  $5.39712234737255e-7$   
 $1/n^{(1/2)} = 1.41421356237310e-2$   
 $\text{difference} = 1.41415959114962e-2$

$$x^3$$

$n = 2000$  , left side =  $5.05980220058544e-6$   
 $1/n^{(1/2)} = 2.23606797749979e-2$   
 $\text{difference} = 2.23556199727973e-2$   
 $n = 5000$  , left side =  $8.09568352105883e-7$   
 $1/n^{(1/2)} = 1.41421356237310e-2$   
 $\text{difference} = 1.41413260553788e-2$

$$x^4$$

$n = 2000$  , left side =  $5.05984931555015e-6$   
 $1/n^{(1/2)} = 2.23606797749979e-2$   
 $\text{difference} = 2.23556199256823e-2$   
 $n = 5000$  , left side =  $8.09569558168910e-7$   
 $1/n^{(1/2)} = 1.41421356237310e-2$   
 $\text{difference} = 1.41413260541728e-2$

$$x^{10}$$

$n = 2000$  , left side =  $5.93100185746322e-7$   
 $1/n^{(1/2)} = 2.23606797749979e-2$   
 $\text{difference} = 2.23600866748122e-2$   
 $n = 5000$  , left side =  $9.48752487690396e-8$   
 $1/n^{(1/2)} = 1.41421356237310e-2$

difference = 1.41420407484822e-2

-----  
x0 = 1/2, Power = 1/2, lamda = 1, q = 1/4  
-----

$$x^{\frac{1}{3}}$$

n = 2000 , left side = 3.66279383739010e-4  
1/n^(1/2) = 2.23606797749979e-2  
difference = 2.19944003912589e-2  
n = 5000 , left side = 1.46628824906569e-4  
1/n^(1/2) = 1.41421356237310e-2  
difference = 1.39955067988244e-2

$$x$$

n = 2000 , left side = 6.93147191573207e-4  
1/n^(1/2) = 2.23606797749979e-2  
difference = 2.16675325834247e-2  
n = 5000 , left side = 2.77258876629438e-4  
1/n^(1/2) = 1.41421356237310e-2  
difference = 1.38648767471015e-2

$$x^2$$

n = 2000 , left side = 6.94533444929368e-4  
1/n^(1/2) = 2.23606797749979e-2  
difference = 2.16661463300685e-2  
n = 5000 , left side = 2.77480677166320e-4  
1/n^(1/2) = 1.41421356237310e-2  
difference = 1.38646549465646e-2

$$x^3$$

```

n = 2000 , left side = 5.21941990297453e-4
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.18387377847004e-2
n = 5000 , left side = 2.08277000138812e-4
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.39338586235921e-2

```

$$x^4$$

```

n = 2000 , left side = 3.48657415094475e-4
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.20120223599034e-2
n = 5000 , left side = 1.38962422999142e-4
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.40031732007318e-2

```

$$x^{10}$$

```

n = 2000 , left side = 1.37838066332147e-5
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.23468959683647e-2
n = 5000 , left side = 5.45433431815541e-6
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.41366812894128e-2

```

-----  
x0 = 1/2, Power = 1/2, lamda = 1, q = 1/2  
-----

$$x^{\frac{1}{3}}$$

```

n = 2000 , left side = 1.83022238704367e-4
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.21776575362935e-2
n = 5000 , left side = 7.32956220087511e-5

```



$1/n^{(1/2)} = 1.41421356237310e-2$   
 difference = 1.40688400017222e-2

$x$

n = 2000 , left side = 3.46573574531495e-4  
 $1/n^{(1/2)} = 2.23606797749979e-2$   
 difference = 2.20141062004664e-2  
 n = 5000 , left side = 1.38629429812687e-4  
 $1/n^{(1/2)} = 1.41421356237310e-2$   
 difference = 1.40035061939183e-2

$x^2$

n = 2000 , left side = 3.47599488122630e-4  
 $1/n^{(1/2)} = 2.23606797749979e-2$   
 difference = 2.20130802868753e-2  
 n = 5000 , left side = 1.38793575987228e-4  
 $1/n^{(1/2)} = 1.41421356237310e-2$   
 difference = 1.40033420477437e-2

$x^3$

n = 2000 , left side = 2.61470034692929e-4  
 $1/n^{(1/2)} = 2.23606797749979e-2$   
 difference = 2.20992097403050e-2  
 n = 5000 , left side = 1.04218354559399e-4  
 $1/n^{(1/2)} = 1.41421356237310e-2$   
 difference = 1.40379172691716e-2

$x^4$

n = 2000 , left side = 1.74827628399418e-4  
 $1/n^{(1/2)} = 2.23606797749979e-2$   
 difference = 2.21858521465985e-2  
 n = 5000 , left side = 6.95610601449959e-5

1/n^(1/2) = 1.41421356237310e-2  
 difference = 1.40725745635860e-2

$$x^{10}$$

n = 2000 , left side = 6.95028639556713e-6  
 1/n^(1/2) = 2.23606797749979e-2  
 difference = 2.23537294886023e-2  
 n = 5000 , left side = 2.73651920556519e-6  
 1/n^(1/2) = 1.41421356237310e-2  
 difference = 1.41393991045254e-2

-----  
 x0 = 1/2, Power = 1/2, lamda = 1, q = 1  
 -----

$$x^{\frac{1}{3}}$$

n = 2000 , left side = 3.19528047798556e-7  
 1/n^(1/2) = 2.23606797749979e-2  
 difference = 2.23603602469501e-2  
 n = 5000 , left side = 5.11242584932958e-8  
 1/n^(1/2) = 1.41421356237310e-2  
 difference = 1.41420844994725e-2

$$x$$

n = 2000 , left side = 0.000000000000000e0  
 1/n^(1/2) = 2.23606797749979e-2  
 difference = 2.23606797749979e-2  
 n = 5000 , left side = 0.000000000000000e0  
 1/n^(1/2) = 1.41421356237310e-2  
 difference = 1.41421356237310e-2

$$x^2$$

```

n = 2000 , left side = 9.05800419392921e-7
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.23597739745785e-2
n = 5000 , left side = 1.44928067158379e-7
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.41419906956638e-2

```

$$x^3$$

```

n = 2000 , left side = 1.35870062942245e-6
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.23593210743685e-2
n = 5000 , left side = 2.17392100737568e-7
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.41419182316302e-2

```

$$x^4$$

```

n = 2000 , left side = 1.35870389404713e-6
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.23593210711038e-2
n = 5000 , left side = 2.17392184295728e-7
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.41419182315467e-2

```

$$x^{10}$$

```

n = 2000 , left side = 1.59233443336286e-7
          1/n^(1/2) = 2.23606797749979e-2
          difference = 2.23605205415546e-2
n = 5000 , left side = 2.54759102073614e-8
          1/n^(1/2) = 1.41421356237310e-2
          difference = 1.41421101478207e-2

```

-----

x0 = 1/2, Power = 7/10, lamda = 1/4, q = 1/4

---

$$x^{\frac{1}{3}}$$

n = 2000 , left side = 1.45973769075280e-3  
1/n^(7/10) = 4.88966384271464e-3  
difference = 3.42992615196184e-3  
n = 5000 , left side = 5.85650001354687e-4  
1/n^(7/10) = 2.57466658709045e-3  
difference = 1.98901658573576e-3

$$x$$

n = 2000 , left side = 2.77258872223973e-3  
1/n^(7/10) = 4.88966384271464e-3  
difference = 2.11707512047491e-3  
n = 5000 , left side = 1.10903548889585e-3  
1/n^(7/10) = 2.57466658709045e-3  
difference = 1.46563109819460e-3

$$x^2$$

n = 2000 , left side = 2.79351877633044e-3  
1/n^(7/10) = 4.88966384271464e-3  
difference = 2.09614506638421e-3  
n = 5000 , left side = 1.11238429755101e-3  
1/n^(7/10) = 2.57466658709045e-3  
difference = 1.46228228953944e-3

$$x^3$$

n = 2000 , left side = 2.11096808695638e-3  
1/n^(7/10) = 4.88966384271464e-3  
difference = 2.77869575575827e-3  
n = 5000 , left side = 8.36808243358689e-4

$1/n^{(7/10)} = 2.57466658709045e-3$   
 difference = 1.73785834373176e-3

$$x^4$$

n = 2000 , left side = 1.41795377434802e-3  
 $1/n^{(7/10)} = 4.88966384271464e-3$   
 difference = 3.47171006836663e-3  
 n = 5000 , left side = 5.59557820777254e-4  
 $1/n^{(7/10)} = 2.57466658709045e-3$   
 difference = 2.01510876631319e-3

$$x^{10}$$

n = 2000 , left side = 5.79591945905002e-5  
 $1/n^{(7/10)} = 4.88966384271464e-3$   
 difference = 4.83170464812414e-3  
 n = 5000 , left side = 2.22575140037271e-5  
 $1/n^{(7/10)} = 2.57466658709045e-3$   
 difference = 2.55240907308672e-3

-----  
 $x_0 = 1/2$ , Power = 7/10, lamda = 1/4, q = 1/2  
 -----

$$x^{\frac{1}{3}}$$

n = 2000 , left side = 7.28207805430148e-4  
 $1/n^{(7/10)} = 4.88966384271464e-3$   
 difference = 4.16145603728450e-3  
 n = 5000 , left side = 2.92559548393356e-4  
 $1/n^{(7/10)} = 2.57466658709045e-3$   
 difference = 2.28210703869709e-3

$$x$$

```

n = 2000 , left side = 1.38629436112003e-3
          1/n^(7/10) = 4.88966384271464e-3
          difference = 3.50336948159461e-3
n = 5000 , left side = 5.54517744448035e-4
          1/n^(7/10) = 2.57466658709045e-3
          difference = 2.02014884264241e-3

```

$$x^2$$

```

n = 2000 , left side = 1.40145897904348e-3
          1/n^(7/10) = 4.88966384271464e-3
          difference = 3.48820486367116e-3
n = 5000 , left side = 5.56944083316024e-4
          1/n^(7/10) = 2.57466658709045e-3
          difference = 2.01772250377442e-3

```

$$x^3$$

```

n = 2000 , left side = 1.06252543720417e-3
          1/n^(7/10) = 4.88966384271464e-3
          difference = 3.82713840551047e-3
n = 5000 , left side = 4.19531511964305e-4
          1/n^(7/10) = 2.57466658709045e-3
          difference = 2.15513507512614e-3

```

$$x^4$$

```

n = 2000 , left side = 7.16010476710327e-4
          1/n^(7/10) = 4.88966384271464e-3
          difference = 4.17365336600432e-3
n = 5000 , left side = 2.80905793970901e-4
          1/n^(7/10) = 2.57466658709045e-3
          difference = 2.29376079311955e-3

```

$$x^{10}$$

```

n = 2000 , left side = 2.97988137052012e-5
          1/n^(7/10) = 4.88966384271464e-3
          difference = 4.85986502900944e-3
n = 5000 , left side = 1.12604691755727e-5
          1/n^(7/10) = 2.57466658709045e-3
          difference = 2.56340611791488e-3

```

-----  
x0 = 1/2, Power = 7/10, lamda = 1/4, q = 1  
-----

$$x^{\frac{1}{3}}$$

```

n = 2000 , left side = 4.67186009045495e-6
          1/n^(7/10) = 4.88966384271464e-3
          difference = 4.88499198262419e-3
n = 5000 , left side = 7.47446048499079e-7
          1/n^(7/10) = 2.57466658709045e-3
          difference = 2.57391914104195e-3

```

$$x$$

```

n = 2000 , left side = 0.000000000000000e0
          1/n^(7/10) = 4.88966384271464e-3
          difference = 4.88966384271464e-3
n = 5000 , left side = 0.000000000000000e0
          1/n^(7/10) = 2.57466658709045e-3
          difference = 2.57466658709045e-3

```

$$x^2$$

```

n = 2000 , left side = 1.32428058677303e-5
          1/n^(7/10) = 4.88966384271464e-3
          difference = 4.87642103684691e-3
n = 5000 , left side = 2.11884893858150e-6

```

1/n^(7/10) = 2.57466658709045e-3  
difference = 2.57254773815187e-3

$$x^3$$

n = 2000 , left side = 1.98642088022338e-5  
1/n^(7/10) = 4.88966384271464e-3  
difference = 4.86979963391241e-3  
n = 5000 , left side = 3.17827340845511e-6  
1/n^(7/10) = 2.57466658709045e-3  
difference = 2.57148831368199e-3

$$x^4$$

n = 2000 , left side = 1.98649427157888e-5  
1/n^(7/10) = 4.88966384271464e-3  
difference = 4.86979889999886e-3  
n = 5000 , left side = 3.17829219639854e-6  
1/n^(7/10) = 2.57466658709045e-3  
difference = 2.57148829489405e-3

$$x^{10}$$

n = 2000 , left side = 2.33024632642588e-6  
1/n^(7/10) = 4.88966384271464e-3  
difference = 4.88733359638822e-3  
n = 5000 , left side = 3.72515568407197e-7  
1/n^(7/10) = 2.57466658709045e-3  
difference = 2.57429407152204e-3

-----  
x0 = 1/2, Power = 7/10, lamda = 1/2, q = 1/4  
-----

$$x^{\frac{1}{3}}$$



```

n = 2000 , left side = 7.31673691973578e-4
           1/n^(7/10) = 4.88966384271464e-3
           difference = 4.15799015074107e-3
n = 5000 , left side = 2.93115579032444e-4
           1/n^(7/10) = 2.57466658709045e-3
           difference = 2.28155100805800e-3

```

$x$

```

n = 2000 , left side = 1.38629436111992e-3
           1/n^(7/10) = 4.88966384271464e-3
           difference = 3.50336948159472e-3
n = 5000 , left side = 5.545177444448035e-4
           1/n^(7/10) = 2.57466658709045e-3
           difference = 2.02014884264241e-3

```

$x^2$

```

n = 2000 , left side = 1.39158937464245e-3
           1/n^(7/10) = 4.88966384271464e-3
           difference = 3.49807446807219e-3
n = 5000 , left side = 5.55364946611514e-4
           1/n^(7/10) = 2.57466658709045e-3
           difference = 2.01930164047893e-3

```

$x^3$

```

n = 2000 , left side = 1.04767998407174e-3
           1/n^(7/10) = 4.88966384271464e-3
           difference = 3.84198385864291e-3
n = 5000 , left side = 4.17160179930126e-4
           1/n^(7/10) = 2.57466658709045e-3
           difference = 2.15750640716032e-3

```

$x^4$

```

n = 2000 , left side = 7.01123176443719e-4
          1/n^(7/10) = 4.88966384271464e-3
          difference = 4.18854066627093e-3
n = 5000 , left side = 2.78531814463245e-4
          1/n^(7/10) = 2.57466658709045e-3
          difference = 2.29613477262720e-3

```

$$x^{10}$$

```

n = 2000 , left side = 2.80227731769833e-5
          1/n^(7/10) = 4.88966384271464e-3
          difference = 4.86164106953766e-3
n = 5000 , left side = 1.09803560975753e-5
          1/n^(7/10) = 2.57466658709045e-3
          difference = 2.56368623099287e-3

```

-----  
x0 = 1/2, Power = 7/10, lamda = 1/2, q = 1/2  
-----

$$x^{\frac{1}{3}}$$

```

n = 2000 , left side = 3.65410972395175e-4
          1/n^(7/10) = 4.88966384271464e-3
          difference = 4.52425287031947e-3
n = 5000 , left side = 1.46489688196749e-4
          1/n^(7/10) = 2.57466658709045e-3
          difference = 2.42817689889370e-3

```

$$x$$

```

n = 2000 , left side = 6.93147180560016e-4
          1/n^(7/10) = 4.88966384271464e-3
          difference = 4.19651666215463e-3
n = 5000 , left side = 2.77258872223851e-4

```

$1/n^{(7/10)} = 2.57466658709045e-3$   
 difference = 2.29740771486660e-3

$x^2$

n = 2000 , left side = 6.97000835040928e-4  
 $1/n^{(7/10)} = 4.88966384271464e-3$   
 difference = 4.19266300767372e-3  
 n = 5000 , left side = 2.77875456940913e-4  
 $1/n^{(7/10)} = 2.57466658709045e-3$   
 difference = 2.29679113014954e-3

$x^3$

n = 2000 , left side = 5.25648214541374e-4  
 $1/n^{(7/10)} = 4.88966384271464e-3$   
 difference = 4.36401562817327e-3  
 n = 5000 , left side = 2.08869501476971e-4  
 $1/n^{(7/10)} = 2.57466658709045e-3$   
 difference = 2.36579708561348e-3

$x^4$

n = 2000 , left side = 3.52368823871019e-4  
 $1/n^{(7/10)} = 4.88966384271464e-3$   
 difference = 4.53729501884363e-3  
 n = 5000 , left side = 1.39555255115609e-4  
 $1/n^{(7/10)} = 2.57466658709045e-3$   
 difference = 2.43511133197484e-3

$x^{10}$

n = 2000 , left side = 1.42225079194571e-5  
 $1/n^{(7/10)} = 4.88966384271464e-3$   
 difference = 4.87544133479519e-3  
 n = 5000 , left side = 5.52404203239387e-6  
 $1/n^{(7/10)} = 2.57466658709045e-3$

difference = 2.56914254505805e-3

-----  
x0 = 1/2, Power = 7/10, lamda = 1/2, q = 1  
-----

$$x^{\frac{1}{3}}$$

n = 2000 , left side = 1.18994097009217e-6  
1/n^(7/10) = 4.88966384271464e-3  
difference = 4.88847390174455e-3  
n = 5000 , left side = 1.90387244969337e-7  
1/n^(7/10) = 2.57466658709045e-3  
difference = 2.57447619984548e-3

$$x$$

n = 2000 , left side = 1.11022302462516e-16  
1/n^(7/10) = 4.88966384271464e-3  
difference = 4.88966384271453e-3  
n = 5000 , left side = 0.0000000000000000e0  
1/n^(7/10) = 2.57466658709045e-3  
difference = 2.57466658709045e-3

$$x^2$$

n = 2000 , left side = 3.37320146703846e-6  
1/n^(7/10) = 4.88966384271464e-3  
difference = 4.88629064124761e-3  
n = 5000 , left side = 5.39712234737255e-7  
1/n^(7/10) = 2.57466658709045e-3  
difference = 2.57412687485571e-3

$$x^3$$

```

n = 2000 , left side = 5.05980220058544e-6
          1/n^(7/10) = 4.88966384271464e-3
          difference = 4.88460404051406e-3
n = 5000 , left side = 8.09568352105883e-7
          1/n^(7/10) = 2.57466658709045e-3
          difference = 2.57385701873834e-3

```

$$x^4$$

```

n = 2000 , left side = 5.05984931555015e-6
          1/n^(7/10) = 4.88966384271464e-3
          difference = 4.88460399339909e-3
n = 5000 , left side = 8.09569558168910e-7
          1/n^(7/10) = 2.57466658709045e-3
          difference = 2.57385701753228e-3

```

$$x^{10}$$

```

n = 2000 , left side = 5.93100185746322e-7
          1/n^(7/10) = 4.88966384271464e-3
          difference = 4.88907074252890e-3
n = 5000 , left side = 9.48752487690396e-8
          1/n^(7/10) = 2.57466658709045e-3
          difference = 2.57457171184168e-3

```

-----  
x0 = 1/2, Power = 7/10, lamda = 1, q = 1/4  
-----

$$x^{\frac{1}{3}}$$

```

n = 2000 , left side = 3.66279383739010e-4
          1/n^(7/10) = 4.88966384271464e-3
          difference = 4.52338445897563e-3
n = 5000 , left side = 1.46628824906569e-4

```

$1/n^{(7/10)} = 2.57466658709045e-3$   
difference = 2.42803776218388e-3

$x$

n = 2000 , left side = 6.93147191573207e-4  
1/n<sup>(7/10)</sup> = 4.88966384271464e-3  
difference = 4.19651665114144e-3  
n = 5000 , left side = 2.77258876629438e-4  
1/n<sup>(7/10)</sup> = 2.57466658709045e-3  
difference = 2.29740771046101e-3

$x^2$

n = 2000 , left side = 6.94533444929368e-4  
1/n<sup>(7/10)</sup> = 4.88966384271464e-3  
difference = 4.19513039778528e-3  
n = 5000 , left side = 2.77480677166320e-4  
1/n<sup>(7/10)</sup> = 2.57466658709045e-3  
difference = 2.29718590992413e-3

$x^3$

n = 2000 , left side = 5.21941990297453e-4  
1/n<sup>(7/10)</sup> = 4.88966384271464e-3  
difference = 4.36772185241719e-3  
n = 5000 , left side = 2.08277000138812e-4  
1/n<sup>(7/10)</sup> = 2.57466658709045e-3  
difference = 2.36638958695164e-3

$x^4$

n = 2000 , left side = 3.48657415094475e-4  
1/n<sup>(7/10)</sup> = 4.88966384271464e-3  
difference = 4.54100642762017e-3  
n = 5000 , left side = 1.38962422999142e-4

1/n^(7/10) = 2.57466658709045e-3  
 difference = 2.43570416409131e-3

$$x^{10}$$

n = 2000 , left side = 1.37838066332147e-5  
 1/n^(7/10) = 4.88966384271464e-3  
 difference = 4.87588003608143e-3  
 n = 5000 , left side = 5.45433431815541e-6  
 1/n^(7/10) = 2.57466658709045e-3  
 difference = 2.56921225277229e-3

-----  
 x0 = 1/2, Power = 7/10, lamda = 1, q = 1/2  
 -----

$$x^{\frac{1}{3}}$$

n = 2000 , left side = 1.83022238704367e-4  
 1/n^(7/10) = 4.88966384271464e-3  
 difference = 4.70664160401028e-3  
 n = 5000 , left side = 7.32956220087511e-5  
 1/n^(7/10) = 2.57466658709045e-3  
 difference = 2.50137096508170e-3

$$x$$

n = 2000 , left side = 3.46573574531495e-4  
 1/n^(7/10) = 4.88966384271464e-3  
 difference = 4.54309026818315e-3  
 n = 5000 , left side = 1.38629429812687e-4  
 1/n^(7/10) = 2.57466658709045e-3  
 difference = 2.43603715727776e-3

$$x^2$$

```

n = 2000 , left side = 3.47599488122630e-4
          1/n^(7/10) = 4.88966384271464e-3
          difference = 4.54206435459201e-3
n = 5000 , left side = 1.38793575987228e-4
          1/n^(7/10) = 2.57466658709045e-3
          difference = 2.43587301110322e-3

```

$$x^3$$

```

n = 2000 , left side = 2.61470034692929e-4
          1/n^(7/10) = 4.88966384271464e-3
          difference = 4.62819380802172e-3
n = 5000 , left side = 1.04218354559399e-4
          1/n^(7/10) = 2.57466658709045e-3
          difference = 2.47044823253105e-3

```

$$x^4$$

```

n = 2000 , left side = 1.74827628399418e-4
          1/n^(7/10) = 4.88966384271464e-3
          difference = 4.71483621431523e-3
n = 5000 , left side = 6.95610601449959e-5
          1/n^(7/10) = 2.57466658709045e-3
          difference = 2.50510552694545e-3

```

$$x^{10}$$

```

n = 2000 , left side = 6.95028639556713e-6
          1/n^(7/10) = 4.88966384271464e-3
          difference = 4.88271355631908e-3
n = 5000 , left side = 2.73651920556519e-6
          1/n^(7/10) = 2.57466658709045e-3
          difference = 2.57193006788488e-3

```

-----



x0 = 1/2, Power = 7/10, lamda = 1, q = 1

---

$$x^{\frac{1}{3}}$$

n = 2000 , left side = 3.19528047798556e-7  
1/n^(7/10) = 4.88966384271464e-3  
difference = 4.88934431466685e-3  
n = 5000 , left side = 5.11242584932958e-8  
1/n^(7/10) = 2.57466658709045e-3  
difference = 2.57461546283196e-3

$$x$$

n = 2000 , left side = 0.000000000000000e0  
1/n^(7/10) = 4.88966384271464e-3  
difference = 4.88966384271464e-3  
n = 5000 , left side = 0.000000000000000e0  
1/n^(7/10) = 2.57466658709045e-3  
difference = 2.57466658709045e-3

$$x^2$$

n = 2000 , left side = 9.05800419392921e-7  
1/n^(7/10) = 4.88966384271464e-3  
difference = 4.88875804229525e-3  
n = 5000 , left side = 1.44928067158379e-7  
1/n^(7/10) = 2.57466658709045e-3  
difference = 2.57452165902329e-3

$$x^3$$

n = 2000 , left side = 1.35870062942245e-6  
1/n^(7/10) = 4.88966384271464e-3  
difference = 4.88830514208522e-3  
n = 5000 , left side = 2.17392100737568e-7

$1/n^{(7/10)} = 2.57466658709045e-3$   
difference = 2.57444919498971e-3

$$x^4$$

n = 2000 , left side = 1.35870389404713e-6  
 $1/n^{(7/10)} = 4.88966384271464e-3$   
difference = 4.88830513882060e-3  
n = 5000 , left side = 2.17392184295728e-7  
 $1/n^{(7/10)} = 2.57466658709045e-3$   
difference = 2.57444919490615e-3

$$x^{10}$$

n = 2000 , left side = 1.59233443336286e-7  
 $1/n^{(7/10)} = 4.88966384271464e-3$   
difference = 4.88950460927131e-3  
n = 5000 , left side = 2.54759102073614e-8  
 $1/n^{(7/10)} = 2.57466658709045e-3$   
difference = 2.57464111118024e-3

## 5 Real-valued neural network approximation based on the q-deformed and $\lambda$ -parametrized half hyperbolic tangent - part 3

```
[ ]: RR.scientific_notation(True)
powers = [3/10, 1/2, 7/10]
lamdas = [1/4, 1/2, 1]    #deformation parameter lamda over (0, 1]
    ↪ 1] - these are the beta values in the formula
qs = [1/4, 1/2, 1]    #deformation coefficient

funcs = [sin(x), cos(x)]    #choice of functions
a = -pi    #the interval
b = pi    #the interval
x0s= [pi/4, pi/2, 3*pi/4]

#####
for x0 in x0s:
    #####
        for power in powers:    #going over various powers for 1/
            ↪ n^power

                ↪
                    #####
                        for lamda in lamdas:    #going over each lamda value

                            ↪
                                #####
                                    for q in qs:    #going over each q value

                                        ↪
                                            #####
                                                print()
                                                print()

                                                    ↪
                                                        print("-----")
                                                            print("x0 = " + str(x0)+", Power = "+
    ↪str(power)+ ", lamda = "+ str(lamda) + ", q = " + str(q))
```

```

    print("-----
           #the activation function
           phi(x) = (1-q*(e^(-lamda*x)))/
    (1+q*(e^(-lamda*x))) #formula 20.1

           #q-deformed and  $\beta$ -parametrized half hyperbolic
    tangent
           theta(x) = 1/4*(phi(x+1) - phi(x-1))
    #formula 20.8

    #####
    for i in range(len(funcs)):
        #####
        f(x)=funcs[i]
        show(f(x))
        for n in [10000, 20000]:
            #def H(n, f, x): #real-valued
    linear neural network operators
            # return sum(f(k/n)*theta(n*x-k)
    for k in [ceil(n*a),...,floor(n*b)])/sum(theta(n*x-k) for k
    in [ceil(n*a),...,floor(n*b)])
            #leftSide = abs(H(n,f,x0)-f(x0))
            leftSide = abs(sum(f(k/
    n)*theta(n*x0-k) for k in [ceil(n*a),...,floor(n*b)])/
    sum(theta(n*x0-k) for k in [ceil(n*a),...,floor(n*b)]) -
    f(x0))

            val1 = n
            val2 = leftSide.n()
            val3 = 1/(n^power).n()

```

```

                                print("          n = "+str(val1), ",\n
↪left side = "+str(val2), "\n                                1/
↪n^("+str(power)+") = "+str(val3), "\n                                \n
↪difference = "+str(val3-val2))

```

-----  
 $x_0 = 1/4\pi$ , Power = 3/10, lamda = 1/4, q = 1/4  
 -----

$\sin(x)$

```

n = 10000 , left side = 3.91807137845590e-4
              1/n^(3/10) = 6.30957344480193e-2
              difference = 6.27039273101737e-2
n = 20000 , left side = 1.95977614287912e-4
              1/n^(3/10) = 5.12496615052604e-2
              difference = 5.10536838909725e-2

```

$\cos(x)$

```

n = 10000 , left side = 3.92399129039323e-4
              1/n^(3/10) = 6.30957344480193e-2
              difference = 6.27033353189800e-2
n = 20000 , left side = 1.96125612112796e-4
              1/n^(3/10) = 5.12496615052604e-2
              difference = 5.10535358931476e-2

```

-----  
 $x_0 = 1/4\pi$ , Power = 3/10, lamda = 1/4, q = 1/2  
 -----

$\sin(x)$

```

n = 10000 , left side = 1.95837114215336e-4

```

```

1/n^(3/10) = 6.30957344480193e-2
difference = 6.28998973338040e-2
n = 20000 , left side = 9.79721925242760e-5
1/n^(3/10) = 5.12496615052604e-2
difference = 5.11516893127361e-2

```

$\cos(x)$

```

n = 10000 , left side = 1.96266034298231e-4
1/n^(3/10) = 6.30957344480193e-2
difference = 6.28994684137211e-2
n = 20000 , left side = 9.80794225604598e-5
1/n^(3/10) = 5.12496615052604e-2
difference = 5.11515820826999e-2

```

-----  
x0 = 1/4\*pi, Power = 3/10, lamda = 1/4, q = 1  
-----

$\sin(x)$

```

n = 10000 , left side = 1.87281521513150e-7
1/n^(3/10) = 6.30957344480193e-2
difference = 6.30955471664978e-2
n = 20000 , left side = 4.68203866788031e-8
1/n^(3/10) = 5.12496615052604e-2
difference = 5.12496146848737e-2

```

$\cos(x)$

```

n = 10000 , left side = 1.87281522623373e-7
1/n^(3/10) = 6.30957344480193e-2
difference = 6.30955471664967e-2
n = 20000 , left side = 4.68203866788031e-8
1/n^(3/10) = 5.12496615052604e-2
difference = 5.12496146848737e-2

```



```

[ ]: RR.scientific_notation(True)
powers = [3/10, 1/2, 7/10]
lamdas = [1/4, 1/2, 1]    #deformation parameter lamda over (0,
    ↪ 1] - these are the beta values in the formula
qs = [1/4, 1/2, 1]    #deformation coefficient

funcs = [x^(1/3), x, x^2, x^3, x^4, x^10]    #choice of
    ↪ functions
a = -1    #the interval
b = 1    #the interval
x0=1/2

for power in powers:
    ↪
    ↪#####
    for lamda in lamdas:    #going over each lamda value
        ↪
        ↪#####
        for q in qs:        #going over each q value
            ↪
            ↪#####
            print()
            print()
            ↪
            ↪print("-----")
            print("x0 = " + str(x0)+", Power = "+ str(power)+
            ↪", lamda = "+ str(lamda) + ", q = " + str(q))
            ↪
            ↪print("-----")
            #the activation function
            phi(x) = (1-q*(e^(-lamda*x)))/(1+q*(e^(-lamda*x)))
            ↪ #formula 20.1

```



```

#q-deformed and  $\beta$ -parametrized half hyperbolic
↪ tangent
theta(x) = 1/4*(phi(x+1) - phi(x-1)) #formula
↪ 20.8

    □
↪ #####
    for i in range(len(funcs)):
        □
↪ #####
        f(x)=funcs[i]
        show(f(x))
        for n in [10000, 20000]:
            #def H(n, f, x): #real-valued linear
↪ neural network operators
            # return sum(f(k/n)*theta(n*x-k) for k
↪ in [ceil(n*a),...,floor(n*b)])/sum(theta(n*x-k) for k in
↪ [ceil(n*a),...,floor(n*b)])
            #leftSide = abs(H(n,f,x0)-f(x0))
            leftSide = abs(sum(f(k/n)*theta(n*x0-k)
↪ for k in [ceil(n*a),...,floor(n*b)])/sum(theta(n*x0-k) for k
↪ in [ceil(n*a),...,floor(n*b)]) - f(x0))

            val1 = n
            val2 = leftSide.n()
            val3 = 1/(n^power).n()
            print("          n = "+str(val1), ", left
↪ side = "+str(val2), "\n          1/
↪ n^("+str(power)+") = "+str(val3), "\n          □
↪ difference = "+str(val3-val2))

```

---

$x_0 = 1/2$ ,  $\text{Power} = 3/10$ ,  $\text{lamda} = 1/4$ ,  $q = 1/4$

---

$$x^{\frac{1}{3}}$$

```

n = 10000 , left side = 2.93119100095551e-4
           1/n^(3/10) = 6.30957344480193e-2
           difference = 6.28026153479238e-2
n = 20000 , left side = 1.46633227955606e-4
           1/n^(3/10) = 5.12496615052604e-2
           difference = 5.11030282773048e-2

```

$$x$$

```

n = 10000 , left side = 5.54517744447813e-4
           1/n^(3/10) = 6.30957344480193e-2
           difference = 6.25412167035715e-2
n = 20000 , left side = 2.77258872223740e-4
           1/n^(3/10) = 5.12496615052604e-2
           difference = 5.09724026330366e-2

```

$$x^2$$

```

n = 10000 , left side = 5.55354946611630e-4
           1/n^(3/10) = 6.30957344480193e-2
           difference = 6.25403795014077e-2
n = 20000 , left side = 2.77468172764916e-4
           1/n^(3/10) = 5.12496615052604e-2
           difference = 5.09721933324955e-2

```

$$x^3$$

```

n = 10000 , left side = 4.17145163294497e-4
           1/n^(3/10) = 6.30957344480193e-2
           difference = 6.26785892847248e-2
n = 20000 , left side = 2.08258236443520e-4
           1/n^(3/10) = 5.12496615052604e-2
           difference = 5.10414032688169e-2

```

$$x^4$$

```
n = 10000 , left side = 2.78516781141852e-4
          1/n^(3/10) = 6.30957344480193e-2
          difference = 6.28172176668775e-2
n = 20000 , left side = 1.38943649991924e-4
          1/n^(3/10) = 5.12496615052604e-2
          difference = 5.11107178552685e-2
```

$$x^{10}$$

```
n = 10000 , left side = 1.09785825246770e-5
          1/n^(3/10) = 6.30957344480193e-2
          difference = 6.30847558654947e-2
n = 20000 , left side = 5.45212716758178e-6
          1/n^(3/10) = 5.12496615052604e-2
          difference = 5.12442093780928e-2
```

-----  
x0 = 1/2, Power = 3/10, lamda = 1/4, q = 1/2  
-----

$$x^{\frac{1}{3}}$$

```
n = 10000 , left side = 1.46493212512588e-4
          1/n^(3/10) = 6.30957344480193e-2
          difference = 6.29492412355067e-2
n = 20000 , left side = 7.33000327566291e-5
          1/n^(3/10) = 5.12496615052604e-2
          difference = 5.11763614725037e-2
```

$$x$$

```
n = 10000 , left side = 2.77258872224073e-4
          1/n^(3/10) = 6.30957344480193e-2
          difference = 6.28184755757953e-2
```

n = 20000 , left side = 1.38629436112425e-4  
 1/n^(3/10) = 5.12496615052604e-2  
 difference = 5.11110320691480e-2

$$x^2$$

n = 10000 , left side = 2.77865456940862e-4  
 1/n^(3/10) = 6.30957344480193e-2  
 difference = 6.28178689910785e-2  
 n = 20000 , left side = 1.38781082291206e-4  
 1/n^(3/10) = 5.12496615052604e-2  
 difference = 5.11108804229692e-2

$$x^3$$

n = 10000 , left side = 2.08854493159272e-4  
 1/n^(3/10) = 6.30957344480193e-2  
 difference = 6.28868799548601e-2  
 n = 20000 , left side = 1.04199604092275e-4  
 1/n^(3/10) = 5.12496615052604e-2  
 difference = 5.11454619011681e-2

$$x^4$$

n = 10000 , left side = 1.39540238443606e-4  
 1/n^(3/10) = 6.30957344480193e-2  
 difference = 6.29561942095757e-2  
 n = 20000 , left side = 6.95423028884978e-5  
 1/n^(3/10) = 5.12496615052604e-2  
 difference = 5.11801192023719e-2

$$x^{10}$$

n = 10000 , left side = 5.52227630148863e-6  
 1/n^(3/10) = 6.30957344480193e-2  
 difference = 6.30902121717178e-2  
 n = 20000 , left side = 2.73431715288003e-6

```
1/n^(3/10) = 5.12496615052604e-2
difference = 5.12469271881075e-2
```

```
-----
x0 = 1/2, Power = 3/10, lamda = 1/4,  q = 1
-----
```

$$x^{\frac{1}{3}}$$

```
n = 10000 , left side = 1.86859671957862e-7
1/n^(3/10) = 6.30957344480193e-2
difference = 6.30955475883474e-2
n = 20000 , left side = 4.67148029148490e-8
1/n^(3/10) = 5.12496615052604e-2
difference = 5.12496147904575e-2
```

$$x$$

```
n = 10000 , left side = 0.0000000000000000e0
1/n^(3/10) = 6.30957344480193e-2
difference = 6.30957344480193e-2
n = 20000 , left side = 0.0000000000000000e0
1/n^(3/10) = 5.12496615052604e-2
difference = 5.12496615052604e-2
```

$$x^2$$

```
n = 10000 , left side = 5.29712234687008e-7
1/n^(3/10) = 6.30957344480193e-2
difference = 6.30952047357846e-2
n = 20000 , left side = 1.32428058685630e-7
1/n^(3/10) = 5.12496615052604e-2
difference = 5.12495290772017e-2
```

$$x^3$$

```

n = 10000 , left side = 7.94568352058267e-7
          1/n^(3/10) = 6.30957344480193e-2
          difference = 6.30949398796673e-2
n = 20000 , left side = 1.98642088000689e-7
          1/n^(3/10) = 5.12496615052604e-2
          difference = 5.12494628631724e-2

```

$$x^4$$

```

n = 10000 , left side = 7.94569526202382e-7
          1/n^(3/10) = 6.30957344480193e-2
          difference = 6.30949398784931e-2
n = 20000 , left side = 1.98642161344798e-7
          1/n^(3/10) = 5.12496615052604e-2
          difference = 5.12494628630990e-2

```

$$x^{10}$$

```

n = 10000 , left side = 9.31173332731437e-8
          1/n^(3/10) = 6.30957344480193e-2
          difference = 6.30956413306861e-2
n = 20000 , left side = 2.32786099916681e-8
          1/n^(3/10) = 5.12496615052604e-2
          difference = 5.12496382266504e-2

```

---

```

x0 = 1/2, Power = 3/10, lamda = 1/2,  q = 1/4

```

---

$$x^{\frac{1}{3}}$$

```

n = 10000 , left side = 1.46632346878617e-4
          1/n^(3/10) = 6.30957344480193e-2
          difference = 6.29491021011407e-2
n = 20000 , left side = 7.33348323107563e-5

```

$1/n^{(3/10)} = 5.12496615052604e-2$   
difference = 5.11763266729496e-2

$x$

n = 10000 , left side = 2.77258872223962e-4  
 $1/n^{(3/10)} = 6.30957344480193e-2$   
difference = 6.28184755757954e-2  
n = 20000 , left side = 1.38629436112314e-4  
 $1/n^{(3/10)} = 5.12496615052604e-2$   
difference = 5.11110320691481e-2

$x^2$

n = 10000 , left side = 2.77470672764957e-4  
 $1/n^{(3/10)} = 6.30957344480193e-2$   
difference = 6.28182637752544e-2  
n = 20000 , left side = 1.38682386247313e-4  
 $1/n^{(3/10)} = 5.12496615052604e-2$   
difference = 5.11109791190131e-2

$x^3$

n = 10000 , left side = 2.08261988522918e-4  
 $1/n^{(3/10)} = 6.30957344480193e-2$   
difference = 6.28874724594964e-2  
n = 20000 , left side = 1.04051518979742e-4  
 $1/n^{(3/10)} = 5.12496615052604e-2$   
difference = 5.11456099862806e-2

$x^4$

n = 10000 , left side = 1.38947404154002e-4  
 $1/n^{(3/10)} = 6.30957344480193e-2$   
difference = 6.29567870438653e-2  
n = 20000 , left side = 6.93941766602424e-5

1/n^(3/10) = 5.12496615052604e-2  
 difference = 5.11802673286001e-2

$$x^{10}$$

n = 10000 , left side = 5.45256858088526e-6  
 1/n^(3/10) = 6.30957344480193e-2  
 difference = 6.30902818794385e-2  
 n = 20000 , left side = 2.71692949489690e-6  
 1/n^(3/10) = 5.12496615052604e-2  
 difference = 5.12469445757655e-2

-----  
 x0 = 1/2, Power = 3/10, lamda = 1/2, q = 1/2  
 -----

$$x^{\frac{1}{3}}$$

n = 10000 , left side = 7.32991512727432e-5  
 1/n^(3/10) = 6.30957344480193e-2  
 difference = 6.30224352967466e-2  
 n = 20000 , left side = 3.66631610069224e-5  
 1/n^(3/10) = 5.12496615052604e-2  
 difference = 5.12129983442535e-2

$$x$$

n = 10000 , left side = 1.38629436112092e-4  
 1/n^(3/10) = 6.30957344480193e-2  
 difference = 6.29571050119072e-2  
 n = 20000 , left side = 6.93147180558240e-5  
 1/n^(3/10) = 5.12496615052604e-2  
 difference = 5.11803467872046e-2

$$x^2$$



```

n = 10000 , left side = 1.38783582291191e-4
           1/n^(3/10) = 6.30957344480193e-2
           difference = 6.29569508657281e-2
n = 20000 , left side = 6.93532546007236e-5
           1/n^(3/10) = 5.12496615052604e-2
           difference = 5.11803082506597e-2

```

$$x^3$$

```

n = 10000 , left side = 1.04203355132004e-4
           1/n^(3/10) = 6.30957344480193e-2
           difference = 6.29915310928873e-2
n = 20000 , left side = 5.20438507066734e-5
           1/n^(3/10) = 5.12496615052604e-2
           difference = 5.11976176545537e-2

```

$$x^4$$

```

n = 10000 , left side = 6.95460549745980e-5
           1/n^(3/10) = 6.30957344480193e-2
           difference = 6.30261883930447e-2
n = 20000 , left side = 3.47151785285438e-5
           1/n^(3/10) = 5.12496615052604e-2
           difference = 5.12149463267318e-2

```

$$x^{10}$$

```

n = 10000 , left side = 2.73475758725585e-6
           1/n^(3/10) = 6.30957344480193e-2
           difference = 6.30929996904321e-2
n = 20000 , left side = 1.36058399651472e-6
           1/n^(3/10) = 5.12496615052604e-2
           difference = 5.12483009212639e-2

```

-----

x0 = 1/2, Power = 3/10, lamda = 1/2, q = 1

---

$$x^{\frac{1}{3}}$$

n = 10000 , left side = 4.75966930313376e-8  
1/n^(3/10) = 6.30957344480193e-2  
difference = 6.30956868513263e-2  
n = 20000 , left side = 1.18991654307621e-8  
1/n^(3/10) = 5.12496615052604e-2  
difference = 5.12496496060949e-2

$$x$$

n = 10000 , left side = 0.000000000000000e0  
1/n^(3/10) = 6.30957344480193e-2  
difference = 6.30957344480193e-2  
n = 20000 , left side = 0.000000000000000e0  
1/n^(3/10) = 5.12496615052604e-2  
difference = 5.12496615052604e-2

$$x^2$$

n = 10000 , left side = 1.34928058781458e-7  
1/n^(3/10) = 6.30957344480193e-2  
difference = 6.30955995199605e-2  
n = 20000 , left side = 3.37320146814868e-8  
1/n^(3/10) = 5.12496615052604e-2  
difference = 5.12496277732457e-2

$$x^3$$

n = 10000 , left side = 2.02392087977898e-7  
1/n^(3/10) = 6.30957344480193e-2  
difference = 6.30955320559314e-2  
n = 20000 , left side = 5.05980219667190e-8

1/n^(3/10) = 5.12496615052604e-2  
 difference = 5.12496109072384e-2

$$x^4$$

n = 10000 , left side = 2.02392163348164e-7  
 1/n^(3/10) = 6.30957344480193e-2  
 difference = 6.30955320558560e-2  
 n = 20000 , left side = 5.05980332216049e-8  
 1/n^(3/10) = 5.12496615052604e-2  
 difference = 5.12496109072272e-2

$$x^{10}$$

n = 10000 , left side = 2.37180700034516e-8  
 1/n^(3/10) = 6.30957344480193e-2  
 difference = 6.30957107299493e-2  
 n = 20000 , left side = 5.92947196507640e-9  
 1/n^(3/10) = 5.12496615052604e-2  
 difference = 5.12496555757884e-2

-----  
 x0 = 1/2, Power = 3/10, lamda = 1, q = 1/4  
 -----

$$x^{\frac{1}{3}}$$

n = 10000 , left side = 7.33339519946030e-5  
 1/n^(3/10) = 6.30957344480193e-2  
 difference = 6.30224004960247e-2  
 n = 20000 , left side = 3.66718634815522e-5  
 1/n^(3/10) = 5.12496615052604e-2  
 difference = 5.12129896417788e-2

$$x$$

```

n = 10000 , left side = 1.38629438315108e-4
           1/n^(3/10) = 6.30957344480193e-2
           difference = 6.29571050097042e-2
n = 20000 , left side = 6.93147191573873e-5
           1/n^(3/10) = 5.12496615052604e-2
           difference = 5.11803467861030e-2

```

$$x^2$$

```

n = 10000 , left side = 1.38684888449037e-4
           1/n^(3/10) = 6.30957344480193e-2
           difference = 6.29570495595703e-2
n = 20000 , left side = 6.93285816908973e-5
           1/n^(3/10) = 5.12496615052604e-2
           difference = 5.11803329235695e-2

```

$$x^3$$

```

n = 10000 , left side = 1.04055271670178e-4
           1/n^(3/10) = 6.30957344480193e-2
           difference = 6.29916791763492e-2
n = 20000 , left side = 5.20068353849767e-5
           1/n^(3/10) = 5.12496615052604e-2
           difference = 5.11976546698754e-2

```

$$x^4$$

```

n = 10000 , left side = 6.93979298337505e-5
           1/n^(3/10) = 6.30957344480193e-2
           difference = 6.30263365181856e-2
n = 20000 , left side = 3.46781577943295e-5
           1/n^(3/10) = 5.12496615052604e-2
           difference = 5.12149833474660e-2

```

$$x^{10}$$

```

n = 10000 , left side = 2.71736996733732e-6
          1/n^(3/10) = 6.30957344480193e-2
          difference = 6.30930170780520e-2
n = 20000 , left side = 1.35624196230164e-6
          1/n^(3/10) = 5.12496615052604e-2
          difference = 5.12483052632981e-2

```

-----  
x0 = 1/2, Power = 3/10, lamda = 1, q = 1/2  
-----

$$x^{\frac{1}{3}}$$

```

n = 10000 , left side = 3.66622776550862e-5
          1/n^(3/10) = 6.30957344480193e-2
          difference = 6.30590721703642e-2
n = 20000 , left side = 1.83347566429237e-5
          1/n^(3/10) = 5.12496615052604e-2
          difference = 5.12313267486175e-2

```

$$x$$

```

n = 10000 , left side = 6.93147149061213e-5
          1/n^(3/10) = 6.30957344480193e-2
          difference = 6.30264197331132e-2
n = 20000 , left side = 3.46573574533382e-5
          1/n^(3/10) = 5.12496615052604e-2
          difference = 5.12150041478070e-2

```

$$x^2$$

```

n = 10000 , left side = 6.93557514499510e-5
          1/n^(3/10) = 6.30957344480193e-2
          difference = 6.30263786965694e-2
n = 20000 , left side = 3.46676165891568e-5

```

1/n^(3/10) = 5.12496615052604e-2  
 difference = 5.12149938886712e-2

$$x^3$$

n = 10000 , left side = 5.20475988626257e-5  
 1/n^(3/10) = 6.30957344480193e-2  
 difference = 6.30436868491567e-2  
 n = 20000 , left side = 2.60084077772782e-5  
 1/n^(3/10) = 5.12496615052604e-2  
 difference = 5.12236530974831e-2

$$x^4$$

n = 10000 , left side = 3.47189280094640e-5  
 1/n^(3/10) = 6.30957344480193e-2  
 difference = 6.30610155200099e-2  
 n = 20000 , left side = 1.73440693989335e-5  
 1/n^(3/10) = 5.12496615052604e-2  
 difference = 5.12323174358614e-2

$$x^{10}$$

n = 10000 , left side = 1.36102387438214e-6  
 1/n^(3/10) = 6.30957344480193e-2  
 difference = 6.30943734241450e-2  
 n = 20000 , left side = 6.78705794970912e-7  
 1/n^(3/10) = 5.12496615052604e-2  
 difference = 5.12489827994654e-2

-----  
 x0 = 1/2, Power = 3/10, lamda = 1, q = 1  
 -----

$$x^{\frac{1}{3}}$$

```

n = 10000 , left side = 1.27810566574738e-8
           1/n^(3/10) = 6.30957344480193e-2
           difference = 6.30957216669627e-2
n = 20000 , left side = 3.19526327619002e-9
           1/n^(3/10) = 5.12496615052604e-2
           difference = 5.12496583099971e-2

```

$x$

```

n = 10000 , left side = 0.000000000000000e0
           1/n^(3/10) = 6.30957344480193e-2
           difference = 6.30957344480193e-2
n = 20000 , left side = 0.000000000000000e0
           1/n^(3/10) = 5.12496615052604e-2
           difference = 5.12496615052604e-2

```

$x^2$

```

n = 10000 , left side = 3.62320168312280e-8
           1/n^(3/10) = 6.30957344480193e-2
           difference = 6.30956982160025e-2
n = 20000 , left side = 9.05800423556258e-9
           1/n^(3/10) = 5.12496615052604e-2
           difference = 5.12496524472561e-2

```

$x^3$

```

n = 10000 , left side = 5.43480251913309e-8
           1/n^(3/10) = 6.30957344480193e-2
           difference = 6.30956800999941e-2
n = 20000 , left side = 1.35870063810994e-8
           1/n^(3/10) = 5.12496615052604e-2
           difference = 5.12496479182540e-2

```

$x^4$

```

n = 10000 , left side = 5.43480303955013e-8
          1/n^(3/10) = 6.30957344480193e-2
          difference = 6.30956800999889e-2
n = 20000 , left side = 1.35869880207862e-8
          1/n^(3/10) = 5.12496615052604e-2
          difference = 5.12496479182724e-2

```

$$x^{10}$$

```

n = 10000 , left side = 6.36892612715552e-9
          1/n^(3/10) = 6.30957344480193e-2
          difference = 6.30957280790932e-2
n = 20000 , left side = 1.59222856145440e-9
          1/n^(3/10) = 5.12496615052604e-2
          difference = 5.12496599130318e-2

```

-----  
x0 = 1/2, Power = 1/2, lamda = 1/4, q = 1/4  
-----

$$x^{\frac{1}{3}}$$

```

n = 10000 , left side = 2.93119100095551e-4
          1/n^(1/2) = 1.00000000000000e-2
          difference = 9.70688089990445e-3
n = 20000 , left side = 1.46633227955606e-4
          1/n^(1/2) = 7.07106781186548e-3
          difference = 6.92443458390987e-3

```

$$x$$

```

n = 10000 , left side = 5.54517744447813e-4
          1/n^(1/2) = 1.00000000000000e-2
          difference = 9.44548225555219e-3
n = 20000 , left side = 2.77258872223740e-4

```



$1/n^{(1/2)} = 7.07106781186548e-3$   
difference = 6.79380893964174e-3

$$x^2$$

n = 10000 , left side = 5.55354946611630e-4  
 $1/n^{(1/2)} = 1.00000000000000e-2$   
difference = 9.44464505338837e-3  
n = 20000 , left side = 2.77468172764916e-4  
 $1/n^{(1/2)} = 7.07106781186548e-3$   
difference = 6.79359963910056e-3

$$x^3$$

n = 10000 , left side = 4.17145163294497e-4  
 $1/n^{(1/2)} = 1.00000000000000e-2$   
difference = 9.58285483670550e-3  
n = 20000 , left side = 2.08258236443520e-4  
 $1/n^{(1/2)} = 7.07106781186548e-3$   
difference = 6.86280957542195e-3

$$x^4$$

n = 10000 , left side = 2.78516781141852e-4  
 $1/n^{(1/2)} = 1.00000000000000e-2$   
difference = 9.72148321885815e-3  
n = 20000 , left side = 1.38943649991924e-4  
 $1/n^{(1/2)} = 7.07106781186548e-3$   
difference = 6.93212416187355e-3

$$x^{10}$$

n = 10000 , left side = 1.09785825246770e-5  
 $1/n^{(1/2)} = 1.00000000000000e-2$   
difference = 9.98902141747532e-3  
n = 20000 , left side = 5.45212716758178e-6  
 $1/n^{(1/2)} = 7.07106781186548e-3$

difference = 7.06561568469789e-3

-----  
x0 = 1/2, Power = 1/2, lamda = 1/4, q = 1/2  
-----

$$x^{\frac{1}{3}}$$

n = 10000 , left side = 1.46493212512588e-4  
1/n^(1/2) = 1.00000000000000e-2  
difference = 9.85350678748741e-3  
n = 20000 , left side = 7.33000327566291e-5  
1/n^(1/2) = 7.07106781186548e-3  
difference = 6.99776777910885e-3

$$x$$

n = 10000 , left side = 2.77258872224073e-4  
1/n^(1/2) = 1.00000000000000e-2  
difference = 9.72274112777593e-3  
n = 20000 , left side = 1.38629436112425e-4  
1/n^(1/2) = 7.07106781186548e-3  
difference = 6.93243837575305e-3

$$x^2$$

n = 10000 , left side = 2.77865456940862e-4  
1/n^(1/2) = 1.00000000000000e-2  
difference = 9.72213454305914e-3  
n = 20000 , left side = 1.38781082291206e-4  
1/n^(1/2) = 7.07106781186548e-3  
difference = 6.93228672957427e-3

$$x^3$$

```

n = 10000 , left side = 2.08854493159272e-4
           1/n^(1/2) = 1.00000000000000e-2
           difference = 9.79114550684073e-3
n = 20000 , left side = 1.04199604092275e-4
           1/n^(1/2) = 7.07106781186548e-3
           difference = 6.96686820777320e-3

```

$$x^4$$

```

n = 10000 , left side = 1.39540238443606e-4
           1/n^(1/2) = 1.00000000000000e-2
           difference = 9.86045976155639e-3
n = 20000 , left side = 6.95423028884978e-5
           1/n^(1/2) = 7.07106781186548e-3
           difference = 7.00152550897698e-3

```

$$x^{10}$$

```

n = 10000 , left side = 5.52227630148863e-6
           1/n^(1/2) = 1.00000000000000e-2
           difference = 9.99447772369851e-3
n = 20000 , left side = 2.73431715288003e-6
           1/n^(1/2) = 7.07106781186548e-3
           difference = 7.06833349471260e-3

```

-----  
x0 = 1/2, Power = 1/2, lamda = 1/4, q = 1  
-----

$$x^{\frac{1}{3}}$$

```

n = 10000 , left side = 1.86859671957862e-7
           1/n^(1/2) = 1.00000000000000e-2
           difference = 9.99981314032804e-3
n = 20000 , left side = 4.67148029148490e-8

```

$1/n^{(1/2)} = 7.07106781186548e-3$   
 difference = 7.07102109706256e-3

$x$

n = 10000 , left side = 0.000000000000000e0  
 $1/n^{(1/2)} = 1.000000000000000e-2$   
 difference = 1.000000000000000e-2  
 n = 20000 , left side = 0.000000000000000e0  
 $1/n^{(1/2)} = 7.07106781186548e-3$   
 difference = 7.07106781186548e-3

$x^2$

n = 10000 , left side = 5.29712234687008e-7  
 $1/n^{(1/2)} = 1.000000000000000e-2$   
 difference = 9.99947028776531e-3  
 n = 20000 , left side = 1.32428058685630e-7  
 $1/n^{(1/2)} = 7.07106781186548e-3$   
 difference = 7.07093538380679e-3

$x^3$

n = 10000 , left side = 7.94568352058267e-7  
 $1/n^{(1/2)} = 1.000000000000000e-2$   
 difference = 9.99920543164794e-3  
 n = 20000 , left side = 1.98642088000689e-7  
 $1/n^{(1/2)} = 7.07106781186548e-3$   
 difference = 7.07086916977747e-3

$x^4$

n = 10000 , left side = 7.94569526202382e-7  
 $1/n^{(1/2)} = 1.000000000000000e-2$   
 difference = 9.99920543047380e-3  
 n = 20000 , left side = 1.98642161344798e-7

$$\begin{aligned} 1/n^{(1/2)} &= 7.07106781186548e-3 \\ \text{difference} &= 7.07086916970413e-3 \end{aligned}$$

$$x^{10}$$

$$\begin{aligned} n = 10000 \text{ , left side} &= 9.31173332731437e-8 \\ 1/n^{(1/2)} &= 1.00000000000000e-2 \\ \text{difference} &= 9.99990688266673e-3 \\ n = 20000 \text{ , left side} &= 2.32786099916681e-8 \\ 1/n^{(1/2)} &= 7.07106781186548e-3 \\ \text{difference} &= 7.07104453325548e-3 \end{aligned}$$

## 6 Real-valued neural network approximation based on q-deformed and $\lambda$ -parametrized A-generalized logistic function - introduction

We present in here some of the background and the main result that was proven in the monograph [Parametrized, Deformed and General Neural Networks, Springer, Heidelberg, New York, 2023], in Chapter 16.

The **activation function** [see monograph, formula 16.1], an A-generalized logistic type function used for this part, is defined as follows:

$$\varphi_{q,\lambda}(x) := \frac{1}{1 + qA^{-\lambda x}}, \forall x \in \mathbb{R}, \text{ where } q, \lambda > 0, A > 1. \quad (5)$$

Then [see monograph, formula 16.5], we present the **density function**:

$$G_{q,\lambda}(x) := \frac{1}{2}(\varphi_{q,\lambda}(x+1) - \varphi_{q,\lambda}(x-1)) > 0, \forall x \in \mathbb{R}. \quad (6)$$

Lastly, [see monograph, formula 16.31], we give the real-valued **linear neural network operators**:

$$L_n(f, x) := \frac{\sum_{k=\lceil na \rceil}^{\lfloor nb \rfloor} f(\frac{k}{n}) G_{q,\lambda}(nx - k)}{\sum_{k=\lceil na \rceil}^{\lfloor nb \rfloor} G_{q,\lambda}(nx - k)}, \text{ where } f \in C([a, b]), x \in [a, b]. \quad (7)$$

It was shown [see monograph, Theorem 16.9], that:

$$\lim_{n \rightarrow \infty} L_n(f) = f, \quad (8)$$

pointwise and uniformly.

Next, we present our computational results using SageMath. Please note that we removed several of the results generated by the code below.

## 7 Real-valued neural network approximation based on q-deformed and $\lambda$ -parametrized A-generalized logistic function

```
[ ]: RR.scientific_notation(True)
powers = [3/10, 1/2, 7/10]
lamdas = [1/4, 1/2, 1]    #deformation parameter lamda over (0, 1] - these are the beta values in the formula
qs = [1/4, 1/2, 1]    #deformation coefficient

As = [2.5, e, 3] #values for A, they all must be > 2

funcs = [sin(x), cos(x)] #choice of functions
a = -pi #the interval
b = pi #the interval
x0s= [pi/4, pi/2, 3*pi/4]

#####
for x0 in x0s:
#####
    for A in As:
        └
        → #####
        for power in powers:    #going over various powers
            → for 1/x^power
                └
                → #####
                for lamda in lamdas: #going over each lamda value
                    └
                    → #####
                    for q in qs:    #going over each q value
                        └
                        → #####
                        print()
```

```

        print()
    □
↪ print("-----
        print("A = "+str(A) + ", Power = "+
↪ str(power)+ ", lamda = "+ str(lamda) + ", q = " + str(q) )
    □
↪ print("-----

        #the activation function
        phi(x) = 1/(1+q*(A^(-lamda*x)))    #formula
↪ 16.1

        #q-deformed and λ-parametrized
↪ A-generalized logistic function
        G(x) = 1/2*(phi(x+1) - phi(x-1))    □
↪ #formula 16.5

    □
↪ #####
        for i in range(len(funcs)):
    □
↪ #####
        f(x)=funcs[i]
        show(f(x))
        for n in [10, 20, 50, 100, 200, 500]:
            #def L(n, f, x):    #real-valued
↪ linear neural network operators
                #    return sum(f(k/n)*G(n*x-k)
↪ for k in [ceil(n*a),...,floor(n*b)])/sum(G(n*x-k) for k in
↪ [ceil(n*a),...,floor(n*b)])
                #leftSide = abs(L(n,f,x0)-f(x0))
                leftSide = abs(sum(f(k/
↪ n)*G(n*x0-k) for k in [ceil(n*a),...,floor(n*b)])/
↪ sum(G(n*x0-k) for k in [ceil(n*a),...,floor(n*b)])-f(x0))
                val1 = n

```



```

        val2 = leftSide.n()
        val3 = 1/(n^power).n()
        print("                n = "+str(val1),
↪", left side = "+str(val2), "\n                1/
↪n^("+str(power)+") = "+str(val3), "\n
↪difference = "+str(val3-val2))

```

-----  
A = 2.500000000000000e0, Power = 3/10, lamda = 1/4, q = 1/4  
-----

$\sin(x)$

```

n = 10 , left side = 4.33415055859522e-2
        1/n^(3/10) = 5.01187233627272e-1
        difference = 4.57845728041320e-1
n = 20 , left side = 1.12552824142944e-1
        1/n^(3/10) = 4.07090531536904e-1
        difference = 2.94537707393960e-1
n = 50 , left side = 7.03650916520144e-2
        1/n^(3/10) = 3.09249494710992e-1
        difference = 2.38884403058977e-1
n = 100 , left side = 3.91179807146498e-2
        1/n^(3/10) = 2.51188643150958e-1
        difference = 2.12070662436308e-1
n = 200 , left side = 2.04958927091282e-2
        1/n^(3/10) = 2.04028577336837e-1
        difference = 1.83532684627709e-1
n = 500 , left side = 8.41628810006989e-3
        1/n^(3/10) = 1.54991898754834e-1
        difference = 1.46575610654764e-1

```

$\cos(x)$

```

n = 10 , left side = 5.56661154693738e-1

```

```

1/n^(3/10) = 5.01187233627272e-1
difference = -5.54739210664653e-2
n = 20 , left side = 2.77375170437838e-1
1/n^(3/10) = 4.07090531536904e-1
difference = 1.29715361099066e-1
n = 50 , left side = 9.82534357579231e-2
1/n^(3/10) = 3.09249494710992e-1
difference = 2.10996058953069e-1
n = 100 , left side = 4.61457320963173e-2
1/n^(3/10) = 2.51188643150958e-1
difference = 2.05042911054641e-1
n = 200 , left side = 2.22563374688898e-2
1/n^(3/10) = 2.04028577336837e-1
difference = 1.81772239867947e-1
n = 500 , left side = 8.69811669306420e-3
1/n^(3/10) = 1.54991898754834e-1
difference = 1.46293782061770e-1

```

-----  
A = 2.50000000000000e0, Power = 3/10, lamda = 1/4, q = 1/2  
-----

```

sin(x)
n = 10 , left side = 4.00887404494789e-2
1/n^(3/10) = 5.01187233627272e-1
difference = 4.61098493177794e-1
n = 20 , left side = 3.83928399692305e-2
1/n^(3/10) = 4.07090531536904e-1
difference = 3.68697691567674e-1
n = 50 , left side = 3.21179292055399e-2
1/n^(3/10) = 3.09249494710992e-1
difference = 2.77131565505452e-1
n = 100 , left side = 1.87795288000223e-2
1/n^(3/10) = 2.51188643150958e-1

```

```

        difference = 2.32409114350936e-1
n = 200 , left side = 1.00516285091354e-2
        1/n^(3/10) = 2.04028577336837e-1
        difference = 1.93976948827702e-1
n = 500 , left side = 4.17660525040209e-3
        1/n^(3/10) = 1.54991898754834e-1
        difference = 1.50815293504432e-1

```

$\cos(x)$

```

n = 10 , left side = 3.51696877135891e-1
        1/n^(3/10) = 5.01187233627272e-1
        difference = 1.49490356491382e-1
n = 20 , left side = 1.58815595821809e-1
        1/n^(3/10) = 4.07090531536904e-1
        difference = 2.48274935715095e-1
n = 50 , left side = 5.23459570459724e-2
        1/n^(3/10) = 3.09249494710992e-1
        difference = 2.56903537665019e-1
n = 100 , left side = 2.38718518518132e-2
        1/n^(3/10) = 2.51188643150958e-1
        difference = 2.27316791299145e-1
n = 200 , left side = 1.13269333013363e-2
        1/n^(3/10) = 2.04028577336837e-1
        difference = 1.92701644035501e-1
n = 500 , left side = 4.38075384751768e-3
        1/n^(3/10) = 1.54991898754834e-1
        difference = 1.50611144907316e-1

```

```

-----
A = 2.500000000000000e0, Power = 3/10, lamda = 1/4,  q = 1
-----

```

$\sin(x)$

$n = 10$  , left side = 1.77934495460432e-1  
 $1/n^{(3/10)} = 5.01187233627272e-1$   
difference = 3.23252738166841e-1  
 $n = 20$  , left side = 5.27726087183127e-2  
 $1/n^{(3/10)} = 4.07090531536904e-1$   
difference = 3.54317922818592e-1  
 $n = 50$  , left side = 8.83573450210706e-3  
 $1/n^{(3/10)} = 3.09249494710992e-1$   
difference = 3.00413760208885e-1  
 $n = 100$  , left side = 2.22349166658886e-3  
 $1/n^{(3/10)} = 2.51188643150958e-1$   
difference = 2.48965151484369e-1  
 $n = 200$  , left side = 5.56789565144489e-4  
 $1/n^{(3/10)} = 2.04028577336837e-1$   
difference = 2.03471787771692e-1  
 $n = 500$  , left side = 8.91274745238313e-5  
 $1/n^{(3/10)} = 1.54991898754834e-1$   
difference = 1.54902771280310e-1

$$\cos(x)$$

$n = 10$  , left side = 1.75729726788694e-1  
 $1/n^{(3/10)} = 5.01187233627272e-1$   
difference = 3.25457506838579e-1  
 $n = 20$  , left side = 5.27555668114590e-2  
 $1/n^{(3/10)} = 4.07090531536904e-1$   
difference = 3.54334964725445e-1  
 $n = 50$  , left side = 8.83573450054709e-3  
 $1/n^{(3/10)} = 3.09249494710992e-1$   
difference = 3.00413760210445e-1  
 $n = 100$  , left side = 2.22349166658842e-3  
 $1/n^{(3/10)} = 2.51188643150958e-1$   
difference = 2.48965151484370e-1  
 $n = 200$  , left side = 5.56789565144933e-4  
 $1/n^{(3/10)} = 2.04028577336837e-1$   
difference = 2.03471787771692e-1

```

n = 500 , left side = 8.91274745232762e-5
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.54902771280310e-1

```

```

-----
A = 2.500000000000000e0, Power = 3/10, lamda = 1/2,  q = 1/4
-----

```

$\sin(x)$

```

n = 10 , left side = 1.11522468155106e-1
          1/n^(3/10) = 5.01187233627272e-1
          difference = 3.89664765472167e-1
n = 20 , left side = 8.25972655210491e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.24493266015855e-1
n = 50 , left side = 3.90806697874810e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.70168824923511e-1
n = 100 , left side = 2.04867976946519e-2
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.30701845456306e-1
n = 200 , left side = 1.04731898731506e-2
          1/n^(3/10) = 2.04028577336837e-1
          difference = 1.93555387463686e-1
n = 500 , left side = 4.24349700945814e-3
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.50748401745376e-1

```

$\cos(x)$

```

n = 10 , left side = 2.77923764210117e-1
          1/n^(3/10) = 5.01187233627272e-1
          difference = 2.23263469417156e-1
n = 20 , left side = 1.26343137611376e-1

```

```

1/n^(3/10) = 4.07090531536904e-1
difference = 2.80747393925528e-1
n = 50 , left side = 4.61787798733720e-2
1/n^(3/10) = 3.09249494710992e-1
difference = 2.63070714837620e-1
n = 100 , left side = 2.22648980816018e-2
1/n^(3/10) = 2.51188643150958e-1
difference = 2.28923745069356e-1
n = 200 , left side = 1.09179387225066e-2
1/n^(3/10) = 2.04028577336837e-1
difference = 1.93110638614330e-1
n = 500 , left side = 4.31466685462656e-3
1/n^(3/10) = 1.54991898754834e-1
difference = 1.50677231900207e-1

```

-----  
A = 2.500000000000000e0, Power = 3/10, lamda = 1/2, q = 1/2  
-----

```

sin(x)
n = 10 , left side = 3.74584607583582e-2
1/n^(3/10) = 5.01187233627272e-1
difference = 4.63728772868914e-1
n = 20 , left side = 3.64476244509963e-2
1/n^(3/10) = 4.07090531536904e-1
difference = 3.70642907085908e-1
n = 50 , left side = 1.87432347869744e-2
1/n^(3/10) = 3.09249494710992e-1
difference = 2.90506259924017e-1
n = 100 , left side = 1.00426640476912e-2
1/n^(3/10) = 2.51188643150958e-1
difference = 2.41145979103267e-1
n = 200 , left side = 5.18624322432149e-3
1/n^(3/10) = 2.04028577336837e-1

```

```

difference = 1.98842334112515e-1
n = 500 , left side = 2.11367686205155e-3
1/n^(3/10) = 1.54991898754834e-1
difference = 1.52878221892782e-1

```

$\cos(x)$

```

n = 10 , left side = 1.59507066998702e-1
1/n^(3/10) = 5.01187233627272e-1
difference = 3.41680166628570e-1
n = 20 , left side = 6.83222057511541e-2
1/n^(3/10) = 4.07090531536904e-1
difference = 3.38768325785750e-1
n = 50 , left side = 2.39060133136003e-2
1/n^(3/10) = 3.09249494710992e-1
difference = 2.85343481397391e-1
n = 100 , left side = 1.13356305313164e-2
1/n^(3/10) = 2.51188643150958e-1
difference = 2.39853012619642e-1
n = 200 , left side = 5.50962710660396e-3
1/n^(3/10) = 2.04028577336837e-1
difference = 1.98518950230233e-1
n = 500 , left side = 2.16542465963676e-3
1/n^(3/10) = 1.54991898754834e-1
difference = 1.52826474095197e-1

```

-----  
A = 2.50000000000000e0, Power = 3/10, lamda = 1/2, q = 1  
-----

$\sin(x)$

```

n = 10 , left side = 5.35915223664589e-2
1/n^(3/10) = 5.01187233627272e-1
difference = 4.47595711260813e-1

```

```

n = 20 , left side = 1.39549631439949e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.93135568392910e-1
n = 50 , left side = 2.25873553736422e-3
          1/n^(3/10) = 3.09249494710992e-1
          difference = 3.06990759173628e-1
n = 100 , left side = 5.65621421640405e-4
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.50623021729318e-1
n = 200 , left side = 1.41464060785079e-4
          1/n^(3/10) = 2.04028577336837e-1
          difference = 2.03887113276052e-1
n = 500 , left side = 2.26368809828070e-5
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.54969261873851e-1

```

$\cos(x)$

```

n = 10 , left side = 5.35766763324740e-2
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.47610557294798e-1
n = 20 , left side = 1.39549626935683e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.93135568843336e-1
n = 50 , left side = 2.25873553736389e-3
          1/n^(3/10) = 3.09249494710992e-1
          difference = 3.06990759173628e-1
n = 100 , left side = 5.65621421639961e-4
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.50623021729318e-1
n = 200 , left side = 1.41464060785523e-4
          1/n^(3/10) = 2.04028577336837e-1
          difference = 2.03887113276051e-1
n = 500 , left side = 2.26368809822519e-5
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.54969261873851e-1

```



-----  
A = 2.500000000000000e0, Power = 3/10, lamda = 1, q = 1/4  
-----

$\sin(x)$

```

n = 10 , left side = 8.16103412926577e-2
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.19576892334615e-1
n = 20 , left side = 4.74002749691844e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.59690256567720e-1
n = 50 , left side = 2.04504182363461e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.88799076474646e-1
n = 100 , left side = 1.04642201544988e-2
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.40724422996459e-1
n = 200 , left side = 5.29091086889000e-3
          1/n^(3/10) = 2.04028577336837e-1
          difference = 1.98737666467947e-1
n = 500 , left side = 2.13035111268967e-3
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.52861547642144e-1

```

$\cos(x)$

```

n = 10 , left side = 1.27068941688299e-1
          1/n^(3/10) = 5.01187233627272e-1
          difference = 3.74118291938974e-1
n = 20 , left side = 5.89128294191317e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.48177702117773e-1
n = 50 , left side = 2.22991398052110e-2

```

```

1/n^(3/10) = 3.09249494710992e-1
difference = 2.86950354905781e-1
n = 100 , left side = 1.09266410803998e-2
1/n^(3/10) = 2.51188643150958e-1
difference = 2.40262002070558e-1
n = 200 , left side = 5.40653113957668e-3
1/n^(3/10) = 2.04028577336837e-1
difference = 1.98622046197260e-1
n = 500 , left side = 2.14885103011964e-3
1/n^(3/10) = 1.54991898754834e-1
difference = 1.52843047724714e-1

```

-----  
A = 2.50000000000000e0, Power = 3/10, lamda = 1, q = 1/2  
-----

$\sin(x)$

```

n = 10 , left side = 3.55183748249535e-2
1/n^(3/10) = 5.01187233627272e-1
difference = 4.65668858802319e-1
n = 20 , left side = 2.23494882434512e-2
1/n^(3/10) = 4.07090531536904e-1
difference = 3.84741043293453e-1
n = 50 , left side = 1.00068068822887e-2
1/n^(3/10) = 3.09249494710992e-1
difference = 2.99242687828703e-1
n = 100 , left side = 5.17733962114941e-3
1/n^(3/10) = 2.51188643150958e-1
difference = 2.46011303529809e-1
n = 200 , left side = 2.63174260535315e-3
1/n^(3/10) = 2.04028577336837e-1
difference = 2.01396834731484e-1
n = 500 , left side = 1.06297961963886e-3
1/n^(3/10) = 1.54991898754834e-1

```

difference = 1.53928919135195e-1

$\cos(x)$

n = 10 , left side = 6.91205199526083e-2  
1/n^(3/10) = 5.01187233627272e-1  
difference = 4.32066713674664e-1  
n = 20 , left side = 3.08451099336924e-2  
1/n^(3/10) = 4.07090531536904e-1  
difference = 3.76245421603212e-1  
n = 50 , left side = 1.13704188189914e-2  
1/n^(3/10) = 3.09249494710992e-1  
difference = 2.97879075892000e-1  
n = 100 , left side = 5.51839709362201e-3  
1/n^(3/10) = 2.51188643150958e-1  
difference = 2.45670246057336e-1  
n = 200 , left side = 2.71701663414470e-3  
1/n^(3/10) = 2.04028577336837e-1  
difference = 2.01311560702692e-1  
n = 500 , left side = 1.07662389694030e-3  
1/n^(3/10) = 1.54991898754834e-1  
difference = 1.53915274857893e-1

-----  
A = 2.50000000000000e0, Power = 3/10, lamda = 1, q = 1  
-----

$\sin(x)$

n = 10 , left side = 1.48212229160279e-2  
1/n^(3/10) = 5.01187233627272e-1  
difference = 4.86366010711244e-1  
n = 20 , left side = 3.74474910286560e-3  
1/n^(3/10) = 4.07090531536904e-1  
difference = 4.03345782434039e-1

```

n = 50 , left side = 6.00948099493515e-4
          1/n^(3/10) = 3.09249494710992e-1
          difference = 3.08648546611498e-1
n = 100 , left side = 1.50301118007068e-4
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.51038342032951e-1
n = 200 , left side = 3.75792730706870e-5
          1/n^(3/10) = 2.04028577336837e-1
          difference = 2.03990998063766e-1
n = 500 , left side = 6.01287285828533e-6
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.54985885881975e-1

```

$\cos(x)$

```

n = 10 , left side = 1.48212218262009e-2
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.86366011801071e-1
n = 20 , left side = 3.74474868435526e-3
          1/n^(3/10) = 4.07090531536904e-1
          difference = 4.03345782852549e-1
n = 50 , left side = 6.00948269517176e-4
          1/n^(3/10) = 3.09249494710992e-1
          difference = 3.08648546441475e-1
n = 100 , left side = 1.50301096831229e-4
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.51038342054127e-1
n = 200 , left side = 3.75792935783936e-5
          1/n^(3/10) = 2.04028577336837e-1
          difference = 2.03990998043259e-1
n = 500 , left side = 6.01285662871209e-6
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.54985885898205e-1

```

-----

A = 2.500000000000000e0, Power = 1/2, lamda = 1/4, q = 1/4

---

$\sin(x)$

n = 10 , left side = 4.33415055859522e-2  
1/n^(1/2) = 3.16227766016838e-1  
difference = 2.72886260430886e-1  
n = 20 , left side = 1.12552824142944e-1  
1/n^(1/2) = 2.23606797749979e-1  
difference = 1.11053973607035e-1  
n = 50 , left side = 7.03650916520144e-2  
1/n^(1/2) = 1.41421356237310e-1  
difference = 7.10562645852951e-2  
n = 100 , left side = 3.91179807146498e-2  
1/n^(1/2) = 1.00000000000000e-1  
difference = 6.08820192853502e-2  
n = 200 , left side = 2.04958927091282e-2  
1/n^(1/2) = 7.07106781186548e-2  
difference = 5.02147854095265e-2  
n = 500 , left side = 8.41628810006989e-3  
1/n^(1/2) = 4.47213595499958e-2  
difference = 3.63050714499259e-2

$\cos(x)$

n = 10 , left side = 5.56661154693738e-1  
1/n^(1/2) = 3.16227766016838e-1  
difference = -2.40433388676900e-1  
n = 20 , left side = 2.77375170437838e-1  
1/n^(1/2) = 2.23606797749979e-1  
difference = -5.37683726878593e-2  
n = 50 , left side = 9.82534357579231e-2  
1/n^(1/2) = 1.41421356237310e-1  
difference = 4.31679204793864e-2  
n = 100 , left side = 4.61457320963173e-2

```

1/n^(1/2) = 1.000000000000000e-1
difference = 5.38542679036827e-2
n = 200 , left side = 2.22563374688898e-2
1/n^(1/2) = 7.07106781186548e-2
difference = 4.84543406497650e-2
n = 500 , left side = 8.69811669306420e-3
1/n^(1/2) = 4.47213595499958e-2
difference = 3.60232428569316e-2

```

-----  
A = 2.500000000000000e0, Power = 1/2, lamda = 1/4, q = 1/2  
-----

```

sin(x)
n = 10 , left side = 4.00887404494789e-2
1/n^(1/2) = 3.16227766016838e-1
difference = 2.76139025567359e-1
n = 20 , left side = 3.83928399692305e-2
1/n^(1/2) = 2.23606797749979e-1
difference = 1.85213957780748e-1
n = 50 , left side = 3.21179292055399e-2
1/n^(1/2) = 1.41421356237310e-1
difference = 1.09303427031770e-1
n = 100 , left side = 1.87795288000223e-2
1/n^(1/2) = 1.000000000000000e-1
difference = 8.12204711999777e-2
n = 200 , left side = 1.00516285091354e-2
1/n^(1/2) = 7.07106781186548e-2
difference = 6.06590496095193e-2
n = 500 , left side = 4.17660525040209e-3
1/n^(1/2) = 4.47213595499958e-2
difference = 4.05447542995937e-2

```

cos(x)

```

n = 10 , left side = 3.51696877135891e-1
          1/n^(1/2) = 3.16227766016838e-1
          difference = -3.54691111190527e-2
n = 20 , left side = 1.58815595821809e-1
          1/n^(1/2) = 2.23606797749979e-1
          difference = 6.47912019281697e-2
n = 50 , left side = 5.23459570459724e-2
          1/n^(1/2) = 1.41421356237310e-1
          difference = 8.90753991913371e-2
n = 100 , left side = 2.38718518518132e-2
          1/n^(1/2) = 1.00000000000000e-1
          difference = 7.61281481481868e-2
n = 200 , left side = 1.13269333013363e-2
          1/n^(1/2) = 7.07106781186548e-2
          difference = 5.93837448173185e-2
n = 500 , left side = 4.38075384751768e-3
          1/n^(1/2) = 4.47213595499958e-2
          difference = 4.03406057024781e-2

```

-----  
A = 2.50000000000000e0, Power = 1/2, lamda = 1/4, q = 1  
-----

$\sin(x)$

```

n = 10 , left side = 1.77934495460432e-1
          1/n^(1/2) = 3.16227766016838e-1
          difference = 1.38293270556406e-1
n = 20 , left side = 5.27726087183127e-2
          1/n^(1/2) = 2.23606797749979e-1
          difference = 1.70834189031666e-1
n = 50 , left side = 8.83573450210706e-3
          1/n^(1/2) = 1.41421356237310e-1
          difference = 1.32585621735202e-1
n = 100 , left side = 2.22349166658886e-3

```

```

1/n^(1/2) = 1.000000000000000e-1
difference = 9.77765083334111e-2
n = 200 , left side = 5.56789565144489e-4
1/n^(1/2) = 7.07106781186548e-2
difference = 7.01538885535103e-2
n = 500 , left side = 8.91274745238313e-5
1/n^(1/2) = 4.47213595499958e-2
difference = 4.46322320754720e-2

```

$\cos(x)$

```

n = 10 , left side = 1.75729726788694e-1
1/n^(1/2) = 3.16227766016838e-1
difference = 1.40498039228144e-1
n = 20 , left side = 5.27555668114590e-2
1/n^(1/2) = 2.23606797749979e-1
difference = 1.70851230938520e-1
n = 50 , left side = 8.83573450054709e-3
1/n^(1/2) = 1.41421356237310e-1
difference = 1.32585621736762e-1
n = 100 , left side = 2.22349166658842e-3
1/n^(1/2) = 1.000000000000000e-1
difference = 9.77765083334116e-2
n = 200 , left side = 5.56789565144933e-4
1/n^(1/2) = 7.07106781186548e-2
difference = 7.01538885535098e-2
n = 500 , left side = 8.91274745232762e-5
1/n^(1/2) = 4.47213595499958e-2
difference = 4.46322320754725e-2

```

-----  
A = 2.500000000000000e0, Power = 1/2, lamda = 1/2, q = 1/4  
-----

$\sin(x)$



$n = 10$  , left side = 1.11522468155106e-1  
 $1/n^{(1/2)} = 3.16227766016838e-1$   
difference = 2.04705297861732e-1  
 $n = 20$  , left side = 8.25972655210491e-2  
 $1/n^{(1/2)} = 2.23606797749979e-1$   
difference = 1.41009532228930e-1  
 $n = 50$  , left side = 3.90806697874810e-2  
 $1/n^{(1/2)} = 1.41421356237310e-1$   
difference = 1.02340686449828e-1  
 $n = 100$  , left side = 2.04867976946519e-2  
 $1/n^{(1/2)} = 1.00000000000000e-1$   
difference = 7.95132023053481e-2  
 $n = 200$  , left side = 1.04731898731506e-2  
 $1/n^{(1/2)} = 7.07106781186548e-2$   
difference = 6.02374882455042e-2  
 $n = 500$  , left side = 4.24349700945814e-3  
 $1/n^{(1/2)} = 4.47213595499958e-2$   
difference = 4.04778625405377e-2

$$\cos(x)$$

$n = 10$  , left side = 2.77923764210117e-1  
 $1/n^{(1/2)} = 3.16227766016838e-1$   
difference = 3.83040018067211e-2  
 $n = 20$  , left side = 1.26343137611376e-1  
 $1/n^{(1/2)} = 2.23606797749979e-1$   
difference = 9.72636601386025e-2  
 $n = 50$  , left side = 4.61787798733720e-2  
 $1/n^{(1/2)} = 1.41421356237310e-1$   
difference = 9.52425763639375e-2  
 $n = 100$  , left side = 2.22648980816018e-2  
 $1/n^{(1/2)} = 1.00000000000000e-1$   
difference = 7.77351019183982e-2  
 $n = 200$  , left side = 1.09179387225066e-2  
 $1/n^{(1/2)} = 7.07106781186548e-2$   
difference = 5.97927393961482e-2

```

n = 500 , left side = 4.31466685462656e-3
          1/n^(1/2) = 4.47213595499958e-2
          difference = 4.04066926953692e-2

```

```

-----
A = 2.500000000000000e0, Power = 1/2, lamda = 1/2,  q = 1/2
-----

```

$\sin(x)$

```

n = 10 , left side = 3.74584607583582e-2
          1/n^(1/2) = 3.16227766016838e-1
          difference = 2.78769305258480e-1
n = 20 , left side = 3.64476244509963e-2
          1/n^(1/2) = 2.23606797749979e-1
          difference = 1.87159173298983e-1
n = 50 , left side = 1.87432347869744e-2
          1/n^(1/2) = 1.41421356237310e-1
          difference = 1.22678121450335e-1
n = 100 , left side = 1.00426640476912e-2
          1/n^(1/2) = 1.00000000000000e-1
          difference = 8.99573359523088e-2
n = 200 , left side = 5.18624322432149e-3
          1/n^(1/2) = 7.07106781186548e-2
          difference = 6.55244348943333e-2
n = 500 , left side = 2.11367686205155e-3
          1/n^(1/2) = 4.47213595499958e-2
          difference = 4.26076826879442e-2

```

$\cos(x)$

```

n = 10 , left side = 1.59507066998702e-1
          1/n^(1/2) = 3.16227766016838e-1
          difference = 1.56720699018136e-1
n = 20 , left side = 6.83222057511541e-2

```

```

1/n^(1/2) = 2.23606797749979e-1
difference = 1.55284591998825e-1
n = 50 , left side = 2.39060133136003e-2
1/n^(1/2) = 1.41421356237310e-1
difference = 1.17515342923709e-1
n = 100 , left side = 1.13356305313164e-2
1/n^(1/2) = 1.00000000000000e-1
difference = 8.86643694686836e-2
n = 200 , left side = 5.50962710660396e-3
1/n^(1/2) = 7.07106781186548e-2
difference = 6.52010510120508e-2
n = 500 , left side = 2.16542465963676e-3
1/n^(1/2) = 4.47213595499958e-2
difference = 4.25559348903590e-2

```

-----  
A = 2.50000000000000e0, Power = 1/2, lamda = 1/2, q = 1  
-----

```

sin(x)
n = 10 , left side = 5.35915223664589e-2
1/n^(1/2) = 3.16227766016838e-1
difference = 2.62636243650379e-1
n = 20 , left side = 1.39549631439949e-2
1/n^(1/2) = 2.23606797749979e-1
difference = 2.09651834605984e-1
n = 50 , left side = 2.25873553736422e-3
1/n^(1/2) = 1.41421356237310e-1
difference = 1.39162620699945e-1
n = 100 , left side = 5.65621421640405e-4
1/n^(1/2) = 1.00000000000000e-1
difference = 9.94343785783596e-2
n = 200 , left side = 1.41464060785079e-4
1/n^(1/2) = 7.07106781186548e-2

```

```

difference = 7.05692140578697e-2
n = 500 , left side = 2.26368809828070e-5
1/n^(1/2) = 4.47213595499958e-2
difference = 4.46987226690130e-2

```

$\cos(x)$

```

n = 10 , left side = 5.35766763324740e-2
1/n^(1/2) = 3.16227766016838e-1
difference = 2.62651089684364e-1
n = 20 , left side = 1.39549626935683e-2
1/n^(1/2) = 2.23606797749979e-1
difference = 2.09651835056411e-1
n = 50 , left side = 2.25873553736389e-3
1/n^(1/2) = 1.41421356237310e-1
difference = 1.39162620699946e-1
n = 100 , left side = 5.65621421639961e-4
1/n^(1/2) = 1.00000000000000e-1
difference = 9.94343785783600e-2
n = 200 , left side = 1.41464060785523e-4
1/n^(1/2) = 7.07106781186548e-2
difference = 7.05692140578692e-2
n = 500 , left side = 2.26368809822519e-5
1/n^(1/2) = 4.47213595499958e-2
difference = 4.46987226690135e-2

```

-----  
A = 2.50000000000000e0, Power = 1/2, lamda = 1, q = 1/4  
-----

$\sin(x)$

```

n = 10 , left side = 8.16103412926577e-2
1/n^(1/2) = 3.16227766016838e-1
difference = 2.34617424724180e-1

```

$n = 20$  , left side = 4.74002749691844e-2  
 $1/n^{(1/2)} = 2.23606797749979e-1$   
difference = 1.76206522780795e-1  
 $n = 50$  , left side = 2.04504182363461e-2  
 $1/n^{(1/2)} = 1.41421356237310e-1$   
difference = 1.20970938000963e-1  
 $n = 100$  , left side = 1.04642201544988e-2  
 $1/n^{(1/2)} = 1.00000000000000e-1$   
difference = 8.95357798455012e-2  
 $n = 200$  , left side = 5.29091086889000e-3  
 $1/n^{(1/2)} = 7.07106781186548e-2$   
difference = 6.54197672497648e-2  
 $n = 500$  , left side = 2.13035111268967e-3  
 $1/n^{(1/2)} = 4.47213595499958e-2$   
difference = 4.25910084373061e-2

$\cos(x)$

$n = 10$  , left side = 1.27068941688299e-1  
 $1/n^{(1/2)} = 3.16227766016838e-1$   
difference = 1.89158824328539e-1  
 $n = 20$  , left side = 5.89128294191317e-2  
 $1/n^{(1/2)} = 2.23606797749979e-1$   
difference = 1.64693968330847e-1  
 $n = 50$  , left side = 2.22991398052110e-2  
 $1/n^{(1/2)} = 1.41421356237310e-1$   
difference = 1.19122216432098e-1  
 $n = 100$  , left side = 1.09266410803998e-2  
 $1/n^{(1/2)} = 1.00000000000000e-1$   
difference = 8.90733589196002e-2  
 $n = 200$  , left side = 5.40653113957668e-3  
 $1/n^{(1/2)} = 7.07106781186548e-2$   
difference = 6.53041469790781e-2  
 $n = 500$  , left side = 2.14885103011964e-3  
 $1/n^{(1/2)} = 4.47213595499958e-2$   
difference = 4.25725085198762e-2

-----  
A = 2.500000000000000e0, Power = 1/2, lamda = 1, q = 1/2  
-----

$\sin(x)$

```

n = 10 , left side = 3.55183748249535e-2
          1/n^(1/2) = 3.16227766016838e-1
          difference = 2.80709391191884e-1
n = 20 , left side = 2.23494882434512e-2
          1/n^(1/2) = 2.23606797749979e-1
          difference = 2.01257309506528e-1
n = 50 , left side = 1.00068068822887e-2
          1/n^(1/2) = 1.41421356237310e-1
          difference = 1.31414549355021e-1
n = 100 , left side = 5.17733962114941e-3
          1/n^(1/2) = 1.00000000000000e-1
          difference = 9.48226603788506e-2
n = 200 , left side = 2.63174260535315e-3
          1/n^(1/2) = 7.07106781186548e-2
          difference = 6.80789355133016e-2
n = 500 , left side = 1.06297961963886e-3
          1/n^(1/2) = 4.47213595499958e-2
          difference = 4.36583799303569e-2

```

$\cos(x)$

```

n = 10 , left side = 6.91205199526083e-2
          1/n^(1/2) = 3.16227766016838e-1
          difference = 2.47107246064230e-1
n = 20 , left side = 3.08451099336924e-2
          1/n^(1/2) = 2.23606797749979e-1
          difference = 1.92761687816287e-1
n = 50 , left side = 1.13704188189914e-2

```

```

1/n^(1/2) = 1.41421356237310e-1
difference = 1.30050937418318e-1
n = 100 , left side = 5.51839709362201e-3
1/n^(1/2) = 1.00000000000000e-1
difference = 9.44816029063780e-2
n = 200 , left side = 2.71701663414470e-3
1/n^(1/2) = 7.07106781186548e-2
difference = 6.79936614845101e-2
n = 500 , left side = 1.07662389694030e-3
1/n^(1/2) = 4.47213595499958e-2
difference = 4.36447356530555e-2

```

-----  
A = 2.50000000000000e0, Power = 1/2, lamda = 1, q = 1  
-----

$\sin(x)$

```

n = 10 , left side = 1.48212229160279e-2
1/n^(1/2) = 3.16227766016838e-1
difference = 3.01406543100810e-1
n = 20 , left side = 3.74474910286560e-3
1/n^(1/2) = 2.23606797749979e-1
difference = 2.19862048647113e-1
n = 50 , left side = 6.00948099493515e-4
1/n^(1/2) = 1.41421356237310e-1
difference = 1.40820408137816e-1
n = 100 , left side = 1.50301118007068e-4
1/n^(1/2) = 1.00000000000000e-1
difference = 9.98496988819929e-2
n = 200 , left side = 3.75792730706870e-5
1/n^(1/2) = 7.07106781186548e-2
difference = 7.06730988455841e-2
n = 500 , left side = 6.01287285828533e-6
1/n^(1/2) = 4.47213595499958e-2

```

difference = 4.47153466771375e-2

$\cos(x)$

n = 10 , left side = 1.48212218262009e-2  
1/n^(1/2) = 3.16227766016838e-1  
difference = 3.01406544190637e-1  
n = 20 , left side = 3.74474868435526e-3  
1/n^(1/2) = 2.23606797749979e-1  
difference = 2.19862049065624e-1  
n = 50 , left side = 6.00948269517176e-4  
1/n^(1/2) = 1.41421356237310e-1  
difference = 1.40820407967792e-1  
n = 100 , left side = 1.50301096831229e-4  
1/n^(1/2) = 1.00000000000000e-1  
difference = 9.98496989031688e-2  
n = 200 , left side = 3.75792935783936e-5  
1/n^(1/2) = 7.07106781186548e-2  
difference = 7.06730988250764e-2  
n = 500 , left side = 6.01285662871209e-6  
1/n^(1/2) = 4.47213595499958e-2  
difference = 4.47153466933671e-2

-----  
A = 2.50000000000000e0, Power = 7/10, lamda = 1/4, q = 1/4  
-----

$\sin(x)$

n = 10 , left side = 4.33415055859522e-2  
1/n^(7/10) = 1.99526231496888e-1  
difference = 1.56184725910936e-1  
n = 20 , left side = 1.12552824142944e-1  
1/n^(7/10) = 1.22822802611579e-1  
difference = 1.02699784686346e-2



```

n = 50 , left side = 7.03650916520144e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = -5.69239099427868e-3
n = 100 , left side = 3.91179807146498e-2
          1/n^(7/10) = 3.98107170553497e-2
          difference = 6.92736340699954e-4
n = 200 , left side = 2.04958927091282e-2
          1/n^(7/10) = 2.45063709469745e-2
          difference = 4.01047823784629e-3
n = 500 , left side = 8.41628810006989e-3
          1/n^(7/10) = 1.29039002429643e-2
          difference = 4.48761214289443e-3

```

$\cos(x)$

```

n = 10 , left side = 5.56661154693738e-1
          1/n^(7/10) = 1.99526231496888e-1
          difference = -3.57134923196850e-1
n = 20 , left side = 2.77375170437838e-1
          1/n^(7/10) = 1.22822802611579e-1
          difference = -1.54552367826259e-1
n = 50 , left side = 9.82534357579231e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = -3.35807351001874e-2
n = 100 , left side = 4.61457320963173e-2
          1/n^(7/10) = 3.98107170553497e-2
          difference = -6.33501504096760e-3
n = 200 , left side = 2.22563374688898e-2
          1/n^(7/10) = 2.45063709469745e-2
          difference = 2.25003347808473e-3
n = 500 , left side = 8.69811669306420e-3
          1/n^(7/10) = 1.29039002429643e-2
          difference = 4.20578354990013e-3

```

-----

A = 2.500000000000000e0, Power = 7/10, lamda = 1/4, q = 1/2

-----

$\sin(x)$

n = 10 , left side = 4.00887404494789e-2  
1/n^(7/10) = 1.99526231496888e-1  
difference = 1.59437491047409e-1  
n = 20 , left side = 3.83928399692305e-2  
1/n^(7/10) = 1.22822802611579e-1  
difference = 8.44299626423486e-2  
n = 50 , left side = 3.21179292055399e-2  
1/n^(7/10) = 6.46727006577358e-2  
difference = 3.25547714521958e-2  
n = 100 , left side = 1.87795288000223e-2  
1/n^(7/10) = 3.98107170553497e-2  
difference = 2.10311882553274e-2  
n = 200 , left side = 1.00516285091354e-2  
1/n^(7/10) = 2.45063709469745e-2  
difference = 1.44547424378391e-2  
n = 500 , left side = 4.17660525040209e-3  
1/n^(7/10) = 1.29039002429643e-2  
difference = 8.72729499256224e-3

$\cos(x)$

n = 10 , left side = 3.51696877135891e-1  
1/n^(7/10) = 1.99526231496888e-1  
difference = -1.52170645639003e-1  
n = 20 , left side = 1.58815595821809e-1  
1/n^(7/10) = 1.22822802611579e-1  
difference = -3.59927932102302e-2  
n = 50 , left side = 5.23459570459724e-2  
1/n^(7/10) = 6.46727006577358e-2  
difference = 1.23267436117633e-2  
n = 100 , left side = 2.38718518518132e-2

```

1/n^(7/10) = 3.98107170553497e-2
difference = 1.59388652035366e-2
n = 200 , left side = 1.13269333013363e-2
1/n^(7/10) = 2.45063709469745e-2
difference = 1.31794376456382e-2
n = 500 , left side = 4.38075384751768e-3
1/n^(7/10) = 1.29039002429643e-2
difference = 8.52314639544664e-3

```

-----  
A = 2.500000000000000e0, Power = 7/10, lamda = 1/4, q = 1  
-----

$\sin(x)$

```

n = 10 , left side = 1.77934495460432e-1
1/n^(7/10) = 1.99526231496888e-1
difference = 2.15917360364564e-2
n = 20 , left side = 5.27726087183127e-2
1/n^(7/10) = 1.22822802611579e-1
difference = 7.00501938932664e-2
n = 50 , left side = 8.83573450210706e-3
1/n^(7/10) = 6.46727006577358e-2
difference = 5.58369661556287e-2
n = 100 , left side = 2.22349166658886e-3
1/n^(7/10) = 3.98107170553497e-2
difference = 3.75872253887609e-2
n = 200 , left side = 5.56789565144489e-4
1/n^(7/10) = 2.45063709469745e-2
difference = 2.39495813818300e-2
n = 500 , left side = 8.91274745238313e-5
1/n^(7/10) = 1.29039002429643e-2
difference = 1.28147727684405e-2

```

$\cos(x)$

```

n = 10 , left side = 1.75729726788694e-1
          1/n^(7/10) = 1.99526231496888e-1
          difference = 2.37965047081943e-2
n = 20 , left side = 5.27555668114590e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 7.00672358001201e-2
n = 50 , left side = 8.83573450054709e-3
          1/n^(7/10) = 6.46727006577358e-2
          difference = 5.58369661571887e-2
n = 100 , left side = 2.22349166658842e-3
          1/n^(7/10) = 3.98107170553497e-2
          difference = 3.75872253887613e-2
n = 200 , left side = 5.56789565144933e-4
          1/n^(7/10) = 2.45063709469745e-2
          difference = 2.39495813818296e-2
n = 500 , left side = 8.91274745232762e-5
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.28147727684410e-2

```

```

-----
A = 2.500000000000000e0, Power = 7/10, lamda = 1/2,  q = 1/4
-----

```

$\sin(x)$

```

n = 10 , left side = 1.11522468155106e-1
          1/n^(7/10) = 1.99526231496888e-1
          difference = 8.80037633417824e-2
n = 20 , left side = 8.25972655210491e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 4.02255370905300e-2
n = 50 , left side = 3.90806697874810e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = 2.55920308702547e-2
n = 100 , left side = 2.04867976946519e-2

```

```

1/n^(7/10) = 3.98107170553497e-2
difference = 1.93239193606978e-2
n = 200 , left side = 1.04731898731506e-2
1/n^(7/10) = 2.45063709469745e-2
difference = 1.40331810738239e-2
n = 500 , left side = 4.24349700945814e-3
1/n^(7/10) = 1.29039002429643e-2
difference = 8.66040323350618e-3

```

$\cos(x)$

```

n = 10 , left side = 2.77923764210117e-1
1/n^(7/10) = 1.99526231496888e-1
difference = -7.83975327132288e-2
n = 20 , left side = 1.26343137611376e-1
1/n^(7/10) = 1.22822802611579e-1
difference = -3.52033499979745e-3
n = 50 , left side = 4.61787798733720e-2
1/n^(7/10) = 6.46727006577358e-2
difference = 1.84939207843637e-2
n = 100 , left side = 2.22648980816018e-2
1/n^(7/10) = 3.98107170553497e-2
difference = 1.75458189737479e-2
n = 200 , left side = 1.09179387225066e-2
1/n^(7/10) = 2.45063709469745e-2
difference = 1.35884322244679e-2
n = 500 , left side = 4.31466685462656e-3
1/n^(7/10) = 1.29039002429643e-2
difference = 8.58923338833776e-3

```

```

[ ]: RR.scientific_notation(True)
powers = [3/10, 1/2, 7/10]
lamdas = [1/4, 1/2, 1]    #deformation parameter lamda over (0, 1]
    ↪ 1] - these are the beta values in the formula
qs = [1/4, 1/2, 1]    #deformation coefficient

```

```

As = [2.5, e, 3] #values for A, they all must be > 2

funcs = [x^(1/3), x, x^2, x^3, x^4, x^10] #choice of functions
a = -1 #the interval
b = 1 #the interval
x0=1/2

for A in As:
    ↳
    ↳ #####
    for power in powers: #going over various powers for 1/
        ↳ n^power
        ↳
        ↳ #####
        for lamda in lamdas: #going over each lamda value
            ↳
            ↳ #####
            for q in qs: #going over each q value
                ↳
                ↳ #####
                print()
                print()
            ↳
            ↳ print("-----
                print("A = "+str(A) + ", Power = "+↳
            ↳ str(power)+ ", lamda = "+ str(lamda) + ", q = " + str(q) )
            ↳
            ↳ print("-----

                #the activation function
                phi(x) = 1/(1+q*(A^(-lamda*x))) #formula 16.
            ↳ 1

```

```

#q-deformed and  $\lambda$ -parametrized A-generalized
↳ logistic function
    G(x) = 1/2*(phi(x+1) - phi(x-1))    #formula
↳ 16.5

    □
↳ #####
    for i in range(len(funcs)):
        □
↳ #####
        f(x)=funcs[i]
        show(f(x))
        for n in [10, 20, 50, 100, 200, 500]:
            #def L(n, f, x):    #real-valued
↳ linear neural network operators
                #    return sum(f(k/n)*G(n*x-k) for k
↳ in [ceil(n*a),...,floor(n*b)])/sum(G(n*x-k) for k in
↳ [ceil(n*a),...,floor(n*b)])
                #leftSide = abs(L(n,f,x0)-f(x0))
                leftSide = abs(sum(f(k/n)*G(n*x0-k)
↳ for k in [ceil(n*a),...,floor(n*b)])/sum(G(n*x0-k) for k in
↳ [ceil(n*a),...,floor(n*b)])-f(x0))
                val1 = n
                val2 = leftSide.n()
                val3 = 1/(n^power).n()
                print("          n = "+str(val1), ",
↳ left side = "+str(val2), " \n          1/
↳ n^("+str(power)+") = "+str(val3), " \n
↳ difference = "+str(val3-val2))

```

---

A = 2.500000000000000e0, Power = 3/10, lamda = 1/4, q = 1/4

---

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 8.95805108030448e-2
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.11606722824228e-1
n = 20 , left side = 4.03416065022316e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.66748925034673e-1
n = 50 , left side = 5.01957151080105e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.59053779602981e-1
n = 100 , left side = 2.88993819229902e-2
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.22289261227968e-1
n = 200 , left side = 1.51899154850691e-2
          1/n^(3/10) = 2.04028577336837e-1
          difference = 1.88838661851768e-1
n = 500 , left side = 6.26780696961507e-3
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.48724091785219e-1

```

$$x$$

```

n = 10 , left side = 1.10241164013081e-2
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.90163117225964e-1
n = 20 , left side = 1.30391177262059e-1
          1/n^(3/10) = 4.07090531536904e-1
          difference = 2.76699354274845e-1
n = 50 , left side = 1.15455286395490e-1
          1/n^(3/10) = 3.09249494710992e-1
          difference = 1.93794208315501e-1
n = 100 , left side = 6.04990591439341e-2
          1/n^(3/10) = 2.51188643150958e-1
          difference = 1.90689584007024e-1
n = 200 , left side = 3.02588316948710e-2

```



```

1/n^(3/10) = 2.04028577336837e-1
difference = 1.73769745641966e-1
n = 500 , left side = 1.21035327578567e-2
1/n^(3/10) = 1.54991898754834e-1
difference = 1.42888365996977e-1

```

$$x^2$$

```

n = 10 , left side = 1.84783029775342e-1
1/n^(3/10) = 5.01187233627272e-1
difference = 3.16404203851931e-1
n = 20 , left side = 2.28619406510606e-1
1/n^(3/10) = 4.07090531536904e-1
difference = 1.78471125026299e-1
n = 50 , left side = 1.51508257176054e-1
1/n^(3/10) = 3.09249494710992e-1
difference = 1.57741237534938e-1
n = 100 , left side = 7.04530962175749e-2
1/n^(3/10) = 2.51188643150958e-1
difference = 1.80735546933383e-1
n = 200 , left side = 3.27501331409030e-2
1/n^(3/10) = 2.04028577336837e-1
difference = 1.71278444195934e-1
n = 500 , left side = 1.25021410068799e-2
1/n^(3/10) = 1.54991898754834e-1
difference = 1.42489757747954e-1

```

$$x^3$$

```

n = 10 , left side = 1.90086031052806e-1
1/n^(3/10) = 5.01187233627272e-1
difference = 3.11101202574466e-1
n = 20 , left side = 2.52641154715191e-1
1/n^(3/10) = 4.07090531536904e-1
difference = 1.54449376821714e-1
n = 50 , left side = 1.49047071418280e-1

```

$1/n^{(3/10)} = 3.09249494710992e-1$   
 $\text{difference} = 1.60202423292712e-1$   
 $n = 100$  ,  $\text{left side} = 6.16649125139612e-2$   
 $1/n^{(3/10)} = 2.51188643150958e-1$   
 $\text{difference} = 1.89523730636997e-1$   
 $n = 200$  ,  $\text{left side} = 2.66018177208146e-2$   
 $1/n^{(3/10)} = 2.04028577336837e-1$   
 $\text{difference} = 1.77426759616022e-1$   
 $n = 500$  ,  $\text{left side} = 9.68648941963357e-3$   
 $1/n^{(3/10)} = 1.54991898754834e-1$   
 $\text{difference} = 1.45305409335200e-1$

$$x^4$$

$n = 10$  ,  $\text{left side} = 2.38473215082664e-1$   
 $1/n^{(3/10)} = 5.01187233627272e-1$   
 $\text{difference} = 2.62714018544608e-1$   
 $n = 20$  ,  $\text{left side} = 2.53702419353397e-1$   
 $1/n^{(3/10)} = 4.07090531536904e-1$   
 $\text{difference} = 1.53388112183508e-1$   
 $n = 50$  ,  $\text{left side} = 1.31978287178406e-1$   
 $1/n^{(3/10)} = 3.09249494710992e-1$   
 $\text{difference} = 1.77271207532586e-1$   
 $n = 100$  ,  $\text{left side} = 4.82143757326847e-2$   
 $1/n^{(3/10)} = 2.51188643150958e-1$   
 $\text{difference} = 2.02974267418273e-1$   
 $n = 200$  ,  $\text{left side} = 1.92277425618226e-2$   
 $1/n^{(3/10)} = 2.04028577336837e-1$   
 $\text{difference} = 1.84800834775014e-1$   
 $n = 500$  ,  $\text{left side} = 6.67204291786003e-3$   
 $1/n^{(3/10)} = 1.54991898754834e-1$   
 $\text{difference} = 1.48319855836974e-1$

$$x^{10}$$

$n = 10$  ,  $\text{left side} = 1.83596290517225e-1$

```

1/n^(3/10) = 5.01187233627272e-1
difference = 3.17590943110047e-1
n = 20 , left side = 1.62012151383724e-1
1/n^(3/10) = 4.07090531536904e-1
difference = 2.45078380153180e-1
n = 50 , left side = 4.46630993804775e-2
1/n^(3/10) = 3.09249494710992e-1
difference = 2.64586395330514e-1
n = 100 , left side = 6.08470988102316e-3
1/n^(3/10) = 2.51188643150958e-1
difference = 2.45103933269935e-1
n = 200 , left side = 1.27521675453629e-3
1/n^(3/10) = 2.04028577336837e-1
difference = 2.02753360582301e-1
n = 500 , left side = 3.18562669012414e-4
1/n^(3/10) = 1.54991898754834e-1
difference = 1.54673336085821e-1

```

-----  
A = 2.50000000000000e0, Power = 3/10, lamda = 1/4, q = 1/2  
-----

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 1.44133199567737e-1
1/n^(3/10) = 5.01187233627272e-1
difference = 3.57054034059535e-1
n = 20 , left side = 2.86253183204823e-2
1/n^(3/10) = 4.07090531536904e-1
difference = 3.78465213216422e-1
n = 50 , left side = 2.08726213332692e-2
1/n^(3/10) = 3.09249494710992e-1
difference = 2.88376873377722e-1
n = 100 , left side = 1.35960908651172e-2
1/n^(3/10) = 2.51188643150958e-1

```

```

        difference = 2.37592552285841e-1
n = 200 , left side = 7.39213207110045e-3
        1/n^(3/10) = 2.04028577336837e-1
        difference = 1.96636445265737e-1
n = 500 , left side = 3.10205780052439e-3
        1/n^(3/10) = 1.54991898754834e-1
        difference = 1.51889840954309e-1

```

$x$

```

n = 10 , left side = 1.05327041372249e-1
        1/n^(3/10) = 5.01187233627272e-1
        difference = 3.95860192255023e-1
n = 20 , left side = 4.13717997457230e-2
        1/n^(3/10) = 4.07090531536904e-1
        difference = 3.65718731791181e-1
n = 50 , left side = 5.73750652034514e-2
        1/n^(3/10) = 3.09249494710992e-1
        difference = 2.51874429507540e-1
n = 100 , left side = 3.02489531671046e-2
        1/n^(3/10) = 2.51188643150958e-1
        difference = 2.20939689983853e-1
n = 200 , left side = 1.51294158443777e-2
        1/n^(3/10) = 2.04028577336837e-1
        difference = 1.88899161492459e-1
n = 500 , left side = 6.05176637892846e-3
        1/n^(3/10) = 1.54991898754834e-1
        difference = 1.48940132375905e-1

```

$x^2$

```

n = 10 , left side = 1.24576123499625e-1
        1/n^(3/10) = 5.01187233627272e-1
        difference = 3.76611110127647e-1
n = 20 , left side = 1.38012858230309e-1
        1/n^(3/10) = 4.07090531536904e-1

```

```

        difference = 2.69077673306596e-1
n = 50 , left side = 8.42822949580354e-2
        1/n^(3/10) = 3.09249494710992e-1
        difference = 2.24967199752956e-1
n = 100 , left side = 3.74617317770052e-2
        1/n^(3/10) = 2.51188643150958e-1
        difference = 2.13726911373953e-1
n = 200 , left side = 1.69340196647313e-2
        1/n^(3/10) = 2.04028577336837e-1
        difference = 1.87094557672106e-1
n = 500 , left side = 6.34050299903632e-3
        1/n^(3/10) = 1.54991898754834e-1
        difference = 1.48651395755797e-1

```

$$x^3$$

```

n = 10 , left side = 1.14879104259545e-1
        1/n^(3/10) = 5.01187233627272e-1
        difference = 3.86308129367727e-1
n = 20 , left side = 1.61686835734369e-1
        1/n^(3/10) = 4.07090531536904e-1
        difference = 2.45403695802536e-1
n = 50 , left side = 8.68813040237145e-2
        1/n^(3/10) = 3.09249494710992e-1
        difference = 2.22368190687277e-1
n = 100 , left side = 3.41025347979198e-2
        1/n^(3/10) = 2.51188643150958e-1
        difference = 2.17086108353038e-1
n = 200 , left side = 1.41289491692595e-2
        1/n^(3/10) = 2.04028577336837e-1
        difference = 1.89899628167577e-1
n = 500 , left side = 4.97672853578127e-3
        1/n^(3/10) = 1.54991898754834e-1
        difference = 1.50015170219052e-1

```

$$x^4$$

$n = 10$  , left side = 1.82279956813131e-1  
 $1/n^{(3/10)} = 5.01187233627272e-1$   
difference = 3.18907276814141e-1  
 $n = 20$  , left side = 1.70069556189843e-1  
 $1/n^{(3/10)} = 4.07090531536904e-1$   
difference = 2.37020975347061e-1  
 $n = 50$  , left side = 7.84096564451796e-2  
 $1/n^{(3/10)} = 3.09249494710992e-1$   
difference = 2.30839838265812e-1  
 $n = 100$  , left side = 2.73369572435774e-2  
 $1/n^{(3/10)} = 2.51188643150958e-1$   
difference = 2.23851685907381e-1  
 $n = 200$  , left side = 1.04341896439651e-2  
 $1/n^{(3/10)} = 2.04028577336837e-1$   
difference = 1.93594387692872e-1  
 $n = 500$  , left side = 3.46890865260507e-3  
 $1/n^{(3/10)} = 1.54991898754834e-1$   
difference = 1.51522990102229e-1

$$x^{10}$$

$n = 10$  , left side = 1.40180143485341e-1  
 $1/n^{(3/10)} = 5.01187233627272e-1$   
difference = 3.61007090141931e-1  
 $n = 20$  , left side = 1.05397442240957e-1  
 $1/n^{(3/10)} = 4.07090531536904e-1$   
difference = 3.01693089295948e-1  
 $n = 50$  , left side = 2.50910783494860e-2  
 $1/n^{(3/10)} = 3.09249494710992e-1$   
difference = 2.84158416361506e-1  
 $n = 100$  , left side = 3.47455758380147e-3  
 $1/n^{(3/10)} = 2.51188643150958e-1$   
difference = 2.47714085567157e-1  
 $n = 200$  , left side = 7.33865491699202e-4  
 $1/n^{(3/10)} = 2.04028577336837e-1$   
difference = 2.03294711845138e-1

```

n = 500 , left side = 1.74590088758720e-4
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.54817308666075e-1

```

```

-----
A = 2.500000000000000e0, Power = 3/10, lamda = 1/4,  q = 1
-----

```

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 2.27494548387138e-1
          1/n^(3/10) = 5.01187233627272e-1
          difference = 2.73692685240134e-1
n = 20 , left side = 9.20097302656440e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.15080801271260e-1
n = 50 , left side = 1.16096864839778e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.97639808227014e-1
n = 100 , left side = 2.33030293971486e-3
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.48858340211243e-1
n = 200 , left side = 5.61472316665541e-4
          1/n^(3/10) = 2.04028577336837e-1
          difference = 2.03467105020171e-1
n = 500 , left side = 8.90740843827344e-5
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.54902824670451e-1

```

$$x$$

```

n = 10 , left side = 2.34214730902041e-1
          1/n^(3/10) = 5.01187233627272e-1
          difference = 2.66972502725231e-1
n = 20 , left side = 6.67035409136132e-2

```

```

1/n^(3/10) = 4.07090531536904e-1
difference = 3.40386990623291e-1
n = 50 , left side = 1.74789407206788e-3
1/n^(3/10) = 3.09249494710992e-1
difference = 3.07501600638924e-1
n = 100 , left side = 5.22756768239763e-6
1/n^(3/10) = 2.51188643150958e-1
difference = 2.51183415583276e-1
n = 200 , left side = 5.30003263499168e-11
1/n^(3/10) = 2.04028577336837e-1
difference = 2.04028577283837e-1
n = 500 , left side = 0.000000000000000e0
1/n^(3/10) = 1.54991898754834e-1
difference = 1.54991898754834e-1

```

$$x^2$$

```

n = 10 , left side = 6.33725534956142e-2
1/n^(3/10) = 5.01187233627272e-1
difference = 4.37814680131658e-1
n = 20 , left side = 4.60805618878404e-2
1/n^(3/10) = 4.07090531536904e-1
difference = 3.61009969649064e-1
n = 50 , left side = 2.24698395749350e-2
1/n^(3/10) = 3.09249494710992e-1
difference = 2.86779655136057e-1
n = 100 , left side = 6.29476386215339e-3
1/n^(3/10) = 2.51188643150958e-1
difference = 2.44893879288805e-1
n = 200 , left side = 1.57570456808348e-3
1/n^(3/10) = 2.04028577336837e-1
difference = 2.02452872768753e-1
n = 500 , left side = 2.52112743802713e-4
1/n^(3/10) = 1.54991898754834e-1
difference = 1.54739786011031e-1

```



$$x^3$$

```

n = 10 , left side = 2.67294554234391e-2
          1/n^(3/10) = 5.01187233627272e-1
          difference = 4.74457778203833e-1
n = 20 , left side = 7.37573763765126e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.33333155160392e-1
n = 50 , left side = 3.43473625906568e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.74902132120335e-1
n = 100 , left side = 9.44446042227745e-3
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.41744182728681e-1
n = 200 , left side = 2.36355687722167e-3
          1/n^(3/10) = 2.04028577336837e-1
          difference = 2.01665020459615e-1
n = 500 , left side = 3.78169115703986e-4
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.54613729639130e-1

```

$$x^4$$

```

n = 10 , left side = 1.28630190484472e-1
          1/n^(3/10) = 5.01187233627272e-1
          difference = 3.72557043142800e-1
n = 20 , left side = 9.56075627237736e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.11482968813131e-1
n = 50 , left side = 3.63531305456022e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.72896364165389e-1
n = 100 , left side = 9.60960509742477e-3
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.41579038053533e-1
n = 200 , left side = 2.37395330358707e-3

```

```

1/n^(3/10) = 2.04028577336837e-1
difference = 2.01654624033250e-1
n = 500 , left side = 3.78435264452900e-4
1/n^(3/10) = 1.54991898754834e-1
difference = 1.54613463490381e-1

```

$$x^{10}$$

```

n = 10 , left side = 1.01874576636765e-1
1/n^(3/10) = 5.01187233627272e-1
difference = 3.99312656990508e-1
n = 20 , left side = 6.28834473578848e-2
1/n^(3/10) = 4.07090531536904e-1
difference = 3.44207084179020e-1
n = 50 , left side = 1.34122210673726e-2
1/n^(3/10) = 3.09249494710992e-1
difference = 2.95837273643619e-1
n = 100 , left side = 1.77904935120004e-3
1/n^(3/10) = 2.51188643150958e-1
difference = 2.49409593799758e-1
n = 200 , left side = 3.13170903900047e-4
1/n^(3/10) = 2.04028577336837e-1
difference = 2.03715406432937e-1
n = 500 , left side = 4.51983446376149e-5
1/n^(3/10) = 1.54991898754834e-1
difference = 1.54946700410196e-1

```

```

-----
A = 2.50000000000000e0, Power = 3/10, lamda = 1/2, q = 1/4
-----

```

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 4.16776482440519e-2
1/n^(3/10) = 5.01187233627272e-1

```

```

        difference = 4.59509585383220e-1
n = 20 , left side = 5.57893515050586e-2
        1/n^(3/10) = 4.07090531536904e-1
        difference = 3.51301180031846e-1
n = 50 , left side = 2.88692145173132e-2
        1/n^(3/10) = 3.09249494710992e-1
        difference = 2.80380280193678e-1
n = 100 , left side = 1.51818158365934e-2
        1/n^(3/10) = 2.51188643150958e-1
        difference = 2.36006827314365e-1
n = 200 , left side = 7.79143245653994e-3
        1/n^(3/10) = 2.04028577336837e-1
        difference = 1.96237144880297e-1
n = 500 , left side = 3.16721387702568e-3
        1/n^(3/10) = 1.54991898754834e-1
        difference = 1.51824684877808e-1

```

$x$

```

n = 10 , left side = 1.39297852044569e-1
        1/n^(3/10) = 5.01187233627272e-1
        difference = 3.61889381582704e-1
n = 20 , left side = 1.35053836660812e-1
        1/n^(3/10) = 4.07090531536904e-1
        difference = 2.72036694876092e-1
n = 50 , left side = 6.05005534742686e-2
        1/n^(3/10) = 3.09249494710992e-1
        difference = 2.48748941236723e-1
n = 100 , left side = 3.02588317119646e-2
        1/n^(3/10) = 2.51188643150958e-1
        difference = 2.20929811438993e-1
n = 200 , left side = 1.51294159473203e-2
        1/n^(3/10) = 2.04028577336837e-1
        difference = 1.88899161389517e-1
n = 500 , left side = 6.05176637892824e-3
        1/n^(3/10) = 1.54991898754834e-1

```

difference = 1.48940132375905e-1

$$x^2$$

n = 10 , left side = 2.43157400570180e-1  
1/n^(3/10) = 5.01187233627272e-1  
difference = 2.58029833057093e-1  
n = 20 , left side = 1.86082180257265e-1  
1/n^(3/10) = 4.07090531536904e-1  
difference = 2.21008351279639e-1  
n = 50 , left side = 7.05553949291386e-2  
1/n^(3/10) = 3.09249494710992e-1  
difference = 2.38694099781853e-1  
n = 100 , left side = 3.27751331669406e-2  
1/n^(3/10) = 2.51188643150958e-1  
difference = 2.18413509984017e-1  
n = 200 , left side = 1.57584913364196e-2  
1/n^(3/10) = 2.04028577336837e-1  
difference = 1.88270086000417e-1  
n = 500 , left side = 6.15241844118397e-3  
1/n^(3/10) = 1.54991898754834e-1  
difference = 1.48839480313650e-1

$$x^3$$

n = 10 , left side = 2.71022498896814e-1  
1/n^(3/10) = 5.01187233627272e-1  
difference = 2.30164734730459e-1  
n = 20 , left side = 1.90670493456831e-1  
1/n^(3/10) = 4.07090531536904e-1  
difference = 2.16420038080073e-1  
n = 50 , left side = 6.18357978326679e-2  
1/n^(3/10) = 3.09249494710992e-1  
difference = 2.47413696878324e-1  
n = 100 , left side = 2.66415871639060e-2  
1/n^(3/10) = 2.51188643150958e-1

```

        difference = 2.24547055987052e-1
n = 200 , left side = 1.23123014505827e-2
        1/n^(3/10) = 2.04028577336837e-1
        difference = 1.91716275886254e-1
n = 500 , left side = 4.69118696759235e-3
        1/n^(3/10) = 1.54991898754834e-1
        difference = 1.50300711787241e-1

```

$$x^4$$

```

n = 10 , left side = 2.75121623894182e-1
        1/n^(3/10) = 5.01187233627272e-1
        difference = 2.26065609733090e-1
n = 20 , left side = 1.76067752001152e-1
        1/n^(3/10) = 4.07090531536904e-1
        difference = 2.31022779535752e-1
n = 50 , left side = 4.84096299223661e-2
        1/n^(3/10) = 3.09249494710992e-1
        difference = 2.60839864788626e-1
n = 100 , left side = 1.92701557399375e-2
        1/n^(3/10) = 2.51188643150958e-1
        difference = 2.31918487411021e-1
n = 200 , left side = 8.55284045364957e-3
        1/n^(3/10) = 2.04028577336837e-1
        difference = 1.95475736883187e-1
n = 500 , left side = 3.17966188740908e-3
        1/n^(3/10) = 1.54991898754834e-1
        difference = 1.51812236867425e-1

```

$$x^{10}$$

```

n = 10 , left side = 1.93566710892432e-1
        1/n^(3/10) = 5.01187233627272e-1
        difference = 3.07620522734841e-1
n = 20 , left side = 7.87869297942849e-2
        1/n^(3/10) = 4.07090531536904e-1

```

```

        difference = 3.28303601742620e-1
n = 50 , left side = 6.16174359721245e-3
        1/n^(3/10) = 3.09249494710992e-1
        difference = 3.03087751113779e-1
n = 100 , left side = 1.28342103628043e-3
        1/n^(3/10) = 2.51188643150958e-1
        difference = 2.49905222114678e-1
n = 200 , left side = 4.31090521057667e-4
        1/n^(3/10) = 2.04028577336837e-1
        difference = 2.03597486815779e-1
n = 500 , left side = 1.37300802767496e-4
        1/n^(3/10) = 1.54991898754834e-1
        difference = 1.54854597952066e-1

```

```

-----
A = 2.500000000000000e0, Power = 3/10, lamda = 1/2,  q = 1/2
-----

```

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 2.77826715380931e-2
        1/n^(3/10) = 5.01187233627272e-1
        difference = 4.73404562089179e-1
n = 20 , left side = 2.03819719834504e-2
        1/n^(3/10) = 4.07090531536904e-1
        difference = 3.86708559553454e-1
n = 50 , left side = 1.35623460940661e-2
        1/n^(3/10) = 3.09249494710992e-1
        difference = 2.95687148616926e-1
n = 100 , left side = 7.38362533994837e-3
        1/n^(3/10) = 2.51188643150958e-1
        difference = 2.43805017811010e-1
n = 200 , left side = 3.84471652289065e-3
        1/n^(3/10) = 2.04028577336837e-1
        difference = 2.00183860813946e-1

```

$n = 500$  , left side = 1.57550867898007e-3  
 $1/n^{(3/10)} = 1.54991898754834e-1$   
difference = 1.53416390075854e-1

$x$

$n = 10$  , left side = 4.75511067244829e-2  
 $1/n^{(3/10)} = 5.01187233627272e-1$   
difference = 4.53636126902789e-1  
 $n = 20$  , left side = 6.62725962575954e-2  
 $1/n^{(3/10)} = 4.07090531536904e-1$   
difference = 3.40817935279309e-1  
 $n = 50$  , left side = 3.02497526014290e-2  
 $1/n^{(3/10)} = 3.09249494710992e-1$   
difference = 2.78999742109563e-1  
 $n = 100$  , left side = 1.51294158532012e-2  
 $1/n^{(3/10)} = 2.51188643150958e-1$   
difference = 2.36059227297757e-1  
 $n = 200$  , left side = 7.56470797366060e-3  
 $1/n^{(3/10)} = 2.04028577336837e-1$   
difference = 1.96463869363176e-1  
 $n = 500$  , left side = 3.02588318946406e-3  
 $1/n^{(3/10)} = 1.54991898754834e-1$   
difference = 1.51966015565370e-1

$x^2$

$n = 10$  , left side = 1.48491297601026e-1  
 $1/n^{(3/10)} = 5.01187233627272e-1$   
difference = 3.52695936026246e-1  
 $n = 20$  , left side = 1.05801778974193e-1  
 $1/n^{(3/10)} = 4.07090531536904e-1$   
difference = 3.01288752562711e-1  
 $n = 50$  , left side = 3.75629381427749e-2  
 $1/n^{(3/10)} = 3.09249494710992e-1$   
difference = 2.71686556568217e-1

$n = 100$  , left side = 1.69590196780399e-2  
 $1/n^{(3/10)} = 2.51188643150958e-1$   
difference = 2.34229623472918e-1  
 $n = 200$  , left side = 8.02210894257893e-3  
 $1/n^{(3/10)} = 2.04028577336837e-1$   
difference = 1.96006468394258e-1  
 $n = 500$  , left side = 3.09906734449100e-3  
 $1/n^{(3/10)} = 1.54991898754834e-1$   
difference = 1.51892831410343e-1

$$x^3$$

$n = 10$  , left side = 1.74543914391627e-1  
 $1/n^{(3/10)} = 5.01187233627272e-1$   
difference = 3.26643319235646e-1  
 $n = 20$  , left side = 1.13936670353400e-1  
 $1/n^{(3/10)} = 4.07090531536904e-1$   
difference = 2.93153861183505e-1  
 $n = 50$  , left side = 3.42630249336759e-2  
 $1/n^{(3/10)} = 3.09249494710992e-1$   
difference = 2.74986469777316e-1  
 $n = 100$  , left side = 1.41675838910336e-2  
 $1/n^{(3/10)} = 2.51188643150958e-1$   
difference = 2.37021059259924e-1  
 $n = 200$  , left side = 6.36914696998986e-3  
 $1/n^{(3/10)} = 2.04028577336837e-1$   
difference = 1.97659430366847e-1  
 $n = 500$  , left side = 2.37979755496609e-3  
 $1/n^{(3/10)} = 1.54991898754834e-1$   
difference = 1.52612101199868e-1

$$x^4$$

$n = 10$  , left side = 1.84936659040297e-1  
 $1/n^{(3/10)} = 5.01187233627272e-1$   
difference = 3.16250574586975e-1



```

n = 20 , left side = 1.07128649322207e-1
          1/n^(3/10) = 4.07090531536904e-1
          difference = 2.99961882214698e-1
n = 50 , left side = 2.75109665690219e-2
          1/n^(3/10) = 3.09249494710992e-1
          difference = 2.81738528141970e-1
n = 100 , left side = 1.04742303886479e-2
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.40714412762310e-1
n = 200 , left side = 4.48828977615331e-3
          1/n^(3/10) = 2.04028577336837e-1
          difference = 1.99540287560684e-1
n = 500 , left side = 1.62395630266564e-3
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.53367942452168e-1

```

$$x^{10}$$

```

n = 10 , left side = 1.25912093995494e-1
          1/n^(3/10) = 5.01187233627272e-1
          difference = 3.75275139631779e-1
n = 20 , left side = 4.50714257301664e-2
          1/n^(3/10) = 4.07090531536904e-1
          difference = 3.62019105806738e-1
n = 50 , left side = 3.52635586284471e-3
          1/n^(3/10) = 3.09249494710992e-1
          difference = 3.05723138848147e-1
n = 100 , left side = 7.40432630933086e-4
          1/n^(3/10) = 2.51188643150958e-1
          difference = 2.50448210520025e-1
n = 200 , left side = 2.39967309324898e-4
          1/n^(3/10) = 2.04028577336837e-1
          difference = 2.03788610027512e-1
n = 500 , left side = 7.26045349905503e-5
          1/n^(3/10) = 1.54991898754834e-1
          difference = 1.54919294219843e-1

```

-----  
A = 3, Power = 7/10, lamda = 1/4, q = 1/4  
-----

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 5.75537791341353e-2
          1/n^(7/10) = 1.99526231496888e-1
          difference = 1.41972452362753e-1
n = 20 , left side = 5.01538635844617e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 7.26689390271174e-2
n = 50 , left side = 4.44369247935306e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = 2.02357758642051e-2
n = 100 , left side = 2.45022894564701e-2
          1/n^(7/10) = 3.98107170553497e-2
          difference = 1.53084275988796e-2
n = 200 , left side = 1.27759995447253e-2
          1/n^(7/10) = 2.45063709469745e-2
          difference = 1.17303714022492e-2
n = 500 , left side = 5.24594907413400e-3
          1/n^(7/10) = 1.29039002429643e-2
          difference = 7.65795116883032e-3

```

$$x$$

```

n = 10 , left side = 4.11343756864777e-2
          1/n^(7/10) = 1.99526231496888e-1
          difference = 1.58391855810410e-1
n = 20 , left side = 1.45618700583181e-1
          1/n^(7/10) = 1.22822802611579e-1
          difference = -2.27958979716023e-2

```

$n = 50$  , left side =  $9.91789471280212e-2$   
 $1/n^{(7/10)} = 6.46727006577358e-2$   
difference =  $-3.45062464702855e-2$   
 $n = 100$  , left side =  $5.04725022113053e-2$   
 $1/n^{(7/10)} = 3.98107170553497e-2$   
difference =  $-1.06617851559555e-2$   
 $n = 200$  , left side =  $2.52371901407978e-2$   
 $1/n^{(7/10)} = 2.45063709469745e-2$   
difference =  $-7.30819193823336e-4$   
 $n = 500$  , left side =  $1.00948760571513e-2$   
 $1/n^{(7/10)} = 1.29039002429643e-2$   
difference =  $2.80902418581301e-3$

$$x^2$$

$n = 10$  , left side =  $2.04066900796696e-1$   
 $1/n^{(7/10)} = 1.99526231496888e-1$   
difference =  $-4.54066929980765e-3$   
 $n = 20$  , left side =  $2.30763289774789e-1$   
 $1/n^{(7/10)} = 1.22822802611579e-1$   
difference =  $-1.07940487163210e-1$   
 $n = 50$  , left side =  $1.25781802608068e-1$   
 $1/n^{(7/10)} = 6.46727006577358e-2$   
difference =  $-6.11091019503323e-2$   
 $n = 100$  , left side =  $5.74136341424519e-2$   
 $1/n^{(7/10)} = 3.98107170553497e-2$   
difference =  $-1.76029170871021e-2$   
 $n = 200$  , left side =  $2.69727481887477e-2$   
 $1/n^{(7/10)} = 2.45063709469745e-2$   
difference =  $-2.46637724177317e-3$   
 $n = 500$  , left side =  $1.03725653449941e-2$   
 $1/n^{(7/10)} = 1.29039002429643e-2$   
difference =  $2.53133489797023e-3$

$$x^3$$

$n = 10$  , left side = 2.22265806381169e-1  
 $1/n^{(7/10)} = 1.99526231496888e-1$   
difference = -2.27395748842808e-2  
 $n = 20$  , left side = 2.51457751362967e-1  
 $1/n^{(7/10)} = 1.22822802611579e-1$   
difference = -1.28634948751388e-1  
 $n = 50$  , left side = 1.19898883779918e-1  
 $1/n^{(7/10)} = 6.46727006577358e-2$   
difference = -5.52261831221819e-2  
 $n = 100$  , left side = 4.90594926169464e-2  
 $1/n^{(7/10)} = 3.98107170553497e-2$   
difference = -9.24877556159666e-3  
 $n = 200$  , left side = 2.16304835738007e-2  
 $1/n^{(7/10)} = 2.45063709469745e-2$   
difference = 2.87588737317385e-3  
 $n = 500$  , left side = 7.99404322403299e-3  
 $1/n^{(7/10)} = 1.29039002429643e-2$   
difference = 4.90985701893133e-3

$$x^4$$

$n = 10$  , left side = 2.53907045566462e-1  
 $1/n^{(7/10)} = 1.99526231496888e-1$   
difference = -5.43808140695738e-2  
 $n = 20$  , left side = 2.47162291851446e-1  
 $1/n^{(7/10)} = 1.22822802611579e-1$   
difference = -1.24339489239867e-1  
 $n = 50$  , left side = 1.02722340452672e-1  
 $1/n^{(7/10)} = 6.46727006577358e-2$   
difference = -3.80496397949363e-2  
 $n = 100$  , left side = 3.73888726022915e-2  
 $1/n^{(7/10)} = 3.98107170553497e-2$   
difference = 2.42184445305824e-3  
 $n = 200$  , left side = 1.54300915414019e-2  
 $1/n^{(7/10)} = 2.45063709469745e-2$   
difference = 9.07627940557259e-3

n = 500 , left side = 5.47692354028259e-3  
 1/n^(7/10) = 1.29039002429643e-2  
 difference = 7.42697670268173e-3

$$x^{10}$$

n = 10 , left side = 1.92937097609011e-1  
 1/n^(7/10) = 1.99526231496888e-1  
 difference = 6.58913388787680e-3  
 n = 20 , left side = 1.49559668336496e-1  
 1/n^(7/10) = 1.22822802611579e-1  
 difference = -2.67368657249171e-2  
 n = 50 , left side = 2.75696561028719e-2  
 1/n^(7/10) = 6.46727006577358e-2  
 difference = 3.71030445548639e-2  
 n = 100 , left side = 3.77940987916722e-3  
 1/n^(7/10) = 3.98107170553497e-2  
 difference = 3.60313071761825e-2  
 n = 200 , left side = 9.30819259943895e-4  
 1/n^(7/10) = 2.45063709469745e-2  
 difference = 2.35755516870306e-2  
 n = 500 , left side = 2.52816609553913e-4  
 1/n^(7/10) = 1.29039002429643e-2  
 difference = 1.26510836334104e-2

-----  
 A = 3, Power = 7/10, lamda = 1/4, q = 1/2  
 -----

$$x^{\frac{1}{3}}$$

n = 10 , left side = 1.07961176896914e-1  
 1/n^(7/10) = 1.99526231496888e-1  
 difference = 9.15650545999738e-2  
 n = 20 , left side = 1.46187478380900e-2

```

1/n^(7/10) = 1.22822802611579e-1
difference = 1.08204054773489e-1
n = 50 , left side = 1.94917100471842e-2
1/n^(7/10) = 6.46727006577358e-2
difference = 4.51809906105515e-2
n = 100 , left side = 1.16676593427210e-2
1/n^(7/10) = 3.98107170553497e-2
difference = 2.81430577126287e-2
n = 200 , left side = 6.24728154686105e-3
1/n^(7/10) = 2.45063709469745e-2
difference = 1.82590894001135e-2
n = 500 , left side = 2.60078820414289e-3
1/n^(7/10) = 1.29039002429643e-2
difference = 1.03031120388214e-2

```

*x*

```

n = 10 , left side = 5.43674197616052e-2
1/n^(7/10) = 1.99526231496888e-1
difference = 1.45158811735283e-1
n = 20 , left side = 5.97131060056814e-2
1/n^(7/10) = 1.22822802611579e-1
difference = 6.31096966058977e-2
n = 50 , left side = 4.94969863858885e-2
1/n^(7/10) = 6.46727006577358e-2
difference = 1.51757142718472e-2
n = 100 , left side = 2.52362028556755e-2
1/n^(7/10) = 3.98107170553497e-2
difference = 1.45745141996742e-2
n = 200 , left side = 1.26185950703714e-2
1/n^(7/10) = 2.45063709469745e-2
difference = 1.18877758766031e-2
n = 500 , left side = 5.04743802855501e-3
1/n^(7/10) = 1.29039002429643e-2
difference = 7.85646221440932e-3

```

$$x^2$$

```

n = 10 , left side = 1.32556015739249e-1
          1/n^(7/10) = 1.99526231496888e-1
          difference = 6.69702157576392e-2
n = 20 , left side = 1.37272215541269e-1
          1/n^(7/10) = 1.22822802611579e-1
          difference = -1.44494129296897e-2
n = 50 , left side = 6.90260023884016e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = -4.35330173066581e-3
n = 100 , left side = 3.02671339674381e-2
          1/n^(7/10) = 3.98107170553497e-2
          difference = 9.54358308791166e-3
n = 200 , left side = 1.38764662941516e-2
          1/n^(7/10) = 2.45063709469745e-2
          difference = 1.06299046528229e-2
n = 500 , left side = 5.24869742446599e-3
          1/n^(7/10) = 1.29039002429643e-2
          difference = 7.65520281849834e-3

```

$$x^3$$

```

n = 10 , left side = 1.40543119011788e-1
          1/n^(7/10) = 1.99526231496888e-1
          difference = 5.89831124850997e-2
n = 20 , left side = 1.58712613139094e-1
          1/n^(7/10) = 1.22822802611579e-1
          difference = -3.58898105275150e-2
n = 50 , left side = 6.88292839445783e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = -4.15658328684251e-3
n = 100 , left side = 2.68220350961968e-2
          1/n^(7/10) = 3.98107170553497e-2
          difference = 1.29886819591529e-2
n = 200 , left side = 1.13943523499742e-2

```

```

1/n^(7/10) = 2.45063709469745e-2
difference = 1.31120185970003e-2
n = 500 , left side = 4.09025796482596e-3
1/n^(7/10) = 1.29039002429643e-2
difference = 8.81364227813837e-3

```

$$x^4$$

```

n = 10 , left side = 1.86776861573453e-1
1/n^(7/10) = 1.99526231496888e-1
difference = 1.27493699234346e-2
n = 20 , left side = 1.60981190569593e-1
1/n^(7/10) = 1.22822802611579e-1
difference = -3.81583879580142e-2
n = 50 , left side = 6.02023592387208e-2
1/n^(7/10) = 6.46727006577358e-2
difference = 4.47034141901495e-3
n = 100 , left side = 2.09592607620394e-2
1/n^(7/10) = 3.98107170553497e-2
difference = 1.88514562933104e-2
n = 200 , left side = 8.28942525108543e-3
1/n^(7/10) = 2.45063709469745e-2
difference = 1.62169456958891e-2
n = 500 , left side = 2.83134554214828e-3
1/n^(7/10) = 1.29039002429643e-2
difference = 1.00725547008160e-2

```

$$x^{10}$$

```

n = 10 , left side = 1.41044486023075e-1
1/n^(7/10) = 1.99526231496888e-1
difference = 5.84817454738132e-2
n = 20 , left side = 9.34299576253183e-2
1/n^(7/10) = 1.22822802611579e-1
difference = 2.93928449862607e-2
n = 50 , left side = 1.54202118287511e-2

```



```

1/n^(7/10) = 6.46727006577358e-2
difference = 4.92524888289847e-2
n = 100 , left side = 2.17644194948917e-3
1/n^(7/10) = 3.98107170553497e-2
difference = 3.76342751058606e-2
n = 200 , left side = 5.32154058320025e-4
1/n^(7/10) = 2.45063709469745e-2
difference = 2.39742168886545e-2
n = 500 , left side = 1.37121741177569e-4
1/n^(7/10) = 1.29039002429643e-2
difference = 1.27667785017868e-2

```

-----  
A = 3, Power = 7/10, lamda = 1/4, q = 1  
-----

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 1.90388797997796e-1
1/n^(7/10) = 1.99526231496888e-1
difference = 9.13743349909243e-3
n = 20 , left side = 6.56235719263559e-2
1/n^(7/10) = 1.22822802611579e-1
difference = 5.71992306852231e-2
n = 50 , left side = 7.42709237196895e-3
1/n^(7/10) = 6.46727006577358e-2
difference = 5.72456082857668e-2
n = 100 , left side = 1.59797012007034e-3
1/n^(7/10) = 3.98107170553497e-2
difference = 3.82127469352794e-2
n = 200 , left side = 3.90256075863404e-4
1/n^(7/10) = 2.45063709469745e-2
difference = 2.41161148711111e-2
n = 500 , left side = 6.20761738443498e-5
1/n^(7/10) = 1.29039002429643e-2

```

difference = 1.28418240691200e-2

$x$

n = 10 , left side = 1.82048832905811e-1  
1/n^(7/10) = 1.99526231496888e-1  
difference = 1.74773985910769e-2  
n = 20 , left side = 3.98117744785634e-2  
1/n^(7/10) = 1.22822802611579e-1  
difference = 8.30110281330157e-2  
n = 50 , left side = 5.34964466007426e-4  
1/n^(7/10) = 6.46727006577358e-2  
difference = 6.41377361917283e-2  
n = 100 , left side = 5.17768589392009e-7  
1/n^(7/10) = 3.98107170553497e-2  
difference = 3.98101992867603e-2  
n = 200 , left side = 5.39956968026445e-13  
1/n^(7/10) = 2.45063709469745e-2  
difference = 2.45063709464345e-2  
n = 500 , left side = 3.38618022510673e-15  
1/n^(7/10) = 1.29039002429643e-2  
difference = 1.29039002429609e-2

$x^2$

n = 10 , left side = 5.88172688754145e-2  
1/n^(7/10) = 1.99526231496888e-1  
difference = 1.40708962621474e-1  
n = 20 , left side = 4.49462410450516e-2  
1/n^(7/10) = 1.22822802611579e-1  
difference = 7.78765615665274e-2  
n = 50 , left side = 1.67425450005100e-2  
1/n^(7/10) = 6.46727006577358e-2  
difference = 4.79301556572258e-2  
n = 100 , left side = 4.39377386083023e-3  
1/n^(7/10) = 3.98107170553497e-2

```

        difference = 3.54169431945195e-2
n = 200 , left side = 1.09864228194106e-3
        1/n^(7/10) = 2.45063709469745e-2
        difference = 2.34077286650334e-2
n = 500 , left side = 1.75782765241383e-4
        1/n^(7/10) = 1.29039002429643e-2
        difference = 1.27281174777229e-2

```

$$x^3$$

```

n = 10 , left side = 4.95124186505144e-2
        1/n^(7/10) = 1.99526231496888e-1
        difference = 1.50013812846374e-1
n = 20 , left side = 7.32951186472261e-2
        1/n^(7/10) = 1.22822802611579e-1
        difference = 4.95276839643529e-2
n = 50 , left side = 2.53238530046482e-2
        1/n^(7/10) = 6.46727006577358e-2
        difference = 3.93488476530876e-2
n = 100 , left side = 6.59089508039287e-3
        1/n^(7/10) = 3.98107170553497e-2
        difference = 3.32198219749569e-2
n = 200 , left side = 1.64796342317008e-3
        1/n^(7/10) = 2.45063709469745e-2
        difference = 2.28584075238044e-2
n = 500 , left side = 2.63674147862936e-4
        1/n^(7/10) = 1.29039002429643e-2
        difference = 1.26402260951014e-2

```

$$x^4$$

```

n = 10 , left side = 1.22860489069735e-1
        1/n^(7/10) = 1.99526231496888e-1
        difference = 7.66657424271527e-2
n = 20 , left side = 8.73610920723158e-2
        1/n^(7/10) = 1.22822802611579e-1

```

```

        difference = 3.54617105392633e-2
n = 50 , left side = 2.64418118614758e-2
        1/n^(7/10) = 6.46727006577358e-2
        difference = 3.82308887962600e-2
n = 100 , left side = 6.67154569006664e-3
        1/n^(7/10) = 3.98107170553497e-2
        difference = 3.31391713652831e-2
n = 200 , left side = 1.65301091267021e-3
        1/n^(7/10) = 2.45063709469745e-2
        difference = 2.28533600343043e-2
n = 500 , left side = 2.63803363596202e-4
        1/n^(7/10) = 1.29039002429643e-2
        difference = 1.26400968793681e-2

```

$$x^{10}$$

```

n = 10 , left side = 9.63190321145369e-2
        1/n^(7/10) = 1.99526231496888e-1
        difference = 1.03207199382351e-1
n = 20 , left side = 5.39093328633610e-2
        1/n^(7/10) = 1.22822802611579e-1
        difference = 6.89134697482180e-2
n = 50 , left side = 8.17939164535952e-3
        1/n^(7/10) = 6.46727006577358e-2
        difference = 5.64933090123762e-2
n = 100 , left side = 1.08271876334556e-3
        1/n^(7/10) = 3.98107170553497e-2
        difference = 3.87279982920042e-2
n = 200 , left side = 2.10380112720596e-4
        1/n^(7/10) = 2.45063709469745e-2
        difference = 2.42959908342539e-2
n = 500 , left side = 3.13261214726040e-5
        1/n^(7/10) = 1.29039002429643e-2
        difference = 1.28725741214917e-2

```

-----  
A = 3, Power = 7/10, lamda = 1/2, q = 1/4  
-----

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 5.10916196819691e-2
          1/n^(7/10) = 1.99526231496888e-1
          difference = 1.48434611814919e-1
n = 20 , left side = 5.13943806064787e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 7.14284220051004e-2
n = 50 , left side = 2.44712193497084e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = 4.02014813080274e-2
n = 100 , left side = 1.27678015370490e-2
          1/n^(7/10) = 3.98107170553497e-2
          difference = 2.70429155183007e-2
n = 200 , left side = 6.52631215849020e-3
          1/n^(7/10) = 2.45063709469745e-2
          difference = 1.79800587884843e-2
n = 500 , left side = 2.64623666471886e-3
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.02576635782455e-2

```

$$x$$

```

n = 10 , left side = 1.52194639517326e-1
          1/n^(7/10) = 1.99526231496888e-1
          difference = 4.73315919795621e-2
n = 20 , left side = 1.19795287408221e-1
          1/n^(7/10) = 1.22822802611579e-1
          difference = 3.02751520335762e-3
n = 50 , left side = 5.04726774830794e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = 1.42000231746564e-2

```

```

n = 100 , left side = 2.52371901410023e-2
          1/n^(7/10) = 3.98107170553497e-2
          difference = 1.45735269143474e-2
n = 200 , left side = 1.26185950714269e-2
          1/n^(7/10) = 2.45063709469745e-2
          difference = 1.18877758755476e-2
n = 500 , left side = 5.04743802857466e-3
          1/n^(7/10) = 1.29039002429643e-2
          difference = 7.85646221438967e-3

```

$$x^2$$

```

n = 10 , left side = 2.42445014784458e-1
          1/n^(7/10) = 1.99526231496888e-1
          difference = -4.29187832875698e-2
n = 20 , left side = 1.59306359409795e-1
          1/n^(7/10) = 1.22822802611579e-1
          difference = -3.64835567982161e-2
n = 50 , left side = 5.75139027256352e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = 7.15879793210053e-3
n = 100 , left side = 2.69977481890565e-2
          1/n^(7/10) = 3.98107170553497e-2
          difference = 1.28129688662933e-2
n = 200 , left side = 1.30587345836964e-2
          1/n^(7/10) = 2.45063709469745e-2
          difference = 1.14476363632781e-2
n = 500 , left side = 5.11786035053458e-3
          1/n^(7/10) = 1.29039002429643e-2
          difference = 7.78603989242975e-3

```

$$x^3$$

```

n = 10 , left side = 2.66755167489386e-1
          1/n^(7/10) = 1.99526231496888e-1
          difference = -6.72289359924984e-2

```

$n = 20$  , left side = 1.58629980626335e-1  
 $1/n^{(7/10)} = 1.22822802611579e-1$   
difference = -3.58071780147563e-2  
 $n = 50$  , left side = 4.92249527212995e-2  
 $1/n^{(7/10)} = 6.46727006577358e-2$   
difference = 1.54477479364363e-2  
 $n = 100$  , left side = 2.16698763634239e-2  
 $1/n^{(7/10)} = 3.98107170553497e-2$   
difference = 1.81408406919259e-2  
 $n = 200$  , left side = 1.01367989077389e-2  
 $1/n^{(7/10)} = 2.45063709469745e-2$   
difference = 1.43695720392356e-2  
 $n = 500$  , left side = 3.89202117786197e-3  
 $1/n^{(7/10)} = 1.29039002429643e-2$   
difference = 9.01187906510235e-3

$$x^4$$

$n = 10$  , left side = 2.65292194687112e-1  
 $1/n^{(7/10)} = 1.99526231496888e-1$   
difference = -6.57659631902237e-2  
 $n = 20$  , left side = 1.42271429061233e-1  
 $1/n^{(7/10)} = 1.22822802611579e-1$   
difference = -1.94486264496542e-2  
 $n = 50$  , left side = 3.75736754012363e-2  
 $1/n^{(7/10)} = 6.46727006577358e-2$   
difference = 2.70990252564995e-2  
 $n = 100$  , left side = 1.54716380790208e-2  
 $1/n^{(7/10)} = 3.98107170553497e-2$   
difference = 2.43390789763290e-2  
 $n = 200$  , left side = 6.99541301099366e-3  
 $1/n^{(7/10)} = 2.45063709469745e-2$   
difference = 1.75109579359808e-2  
 $n = 500$  , left side = 2.63098670431283e-3  
 $1/n^{(7/10)} = 1.29039002429643e-2$   
difference = 1.02729135386515e-2

$$x^{10}$$

```

n = 10 , left side = 1.76981933661658e-1
          1/n^(7/10) = 1.99526231496888e-1
          difference = 2.25442978352297e-2
n = 20 , left side = 5.30759628976999e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 6.97468397138791e-2
n = 50 , left side = 3.83563208999783e-3
          1/n^(7/10) = 6.46727006577358e-2
          difference = 6.08370685677379e-2
n = 100 , left side = 9.38095725961607e-4
          1/n^(7/10) = 3.98107170553497e-2
          difference = 3.88726213293881e-2
n = 200 , left side = 3.37944406623273e-4
          1/n^(7/10) = 2.45063709469745e-2
          difference = 2.41684265403512e-2
n = 500 , left side = 1.11774573310479e-4
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.27921256696538e-2

```

-----  
A = 3, Power = 7/10, lamda = 1/2, q = 1/2  
-----

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 1.37606830853123e-2
          1/n^(7/10) = 1.99526231496888e-1
          difference = 1.85765548411576e-1
n = 20 , left side = 2.07942408318349e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 1.02028561779744e-1
n = 50 , left side = 1.16338810728552e-2
          1/n^(7/10) = 6.46727006577358e-2

```



```

        difference = 5.30388195848805e-2
n = 100 , left side = 6.23874050740880e-3
        1/n^(7/10) = 3.98107170553497e-2
        difference = 3.35719765479409e-2
n = 200 , left side = 3.22731032813994e-3
        1/n^(7/10) = 2.45063709469745e-2
        difference = 2.12790606188346e-2
n = 500 , left side = 1.31741761047521e-3
        1/n^(7/10) = 1.29039002429643e-2
        difference = 1.15864826324891e-2

```

$x$

```

n = 10 , left side = 6.41256145303283e-2
        1/n^(7/10) = 1.99526231496888e-1
        difference = 1.35400616966560e-1
n = 20 , left side = 5.94887988577303e-2
        1/n^(7/10) = 1.22822802611579e-1
        difference = 6.33340037538488e-2
n = 50 , left side = 2.52362954947459e-2
        1/n^(7/10) = 6.46727006577358e-2
        difference = 3.94364051629898e-2
n = 100 , left side = 1.26185950704787e-2
        1/n^(7/10) = 3.98107170553497e-2
        difference = 2.71921219848710e-2
n = 200 , left side = 6.30929753571374e-3
        1/n^(7/10) = 2.45063709469745e-2
        difference = 1.81970734112608e-2
n = 500 , left side = 2.52371901428061e-3
        1/n^(7/10) = 1.29039002429643e-2
        difference = 1.03801812286837e-2

```

$x^2$

```

n = 10 , left side = 1.45653364930992e-1
        1/n^(7/10) = 1.99526231496888e-1

```

```

        difference = 5.38728665658960e-2
n = 20 , left side = 8.92331669463914e-2
        1/n^(7/10) = 1.22822802611579e-1
        difference = 3.35896356651877e-2
n = 50 , left side = 3.03672736409643e-2
        1/n^(7/10) = 6.46727006577358e-2
        difference = 3.43054270167714e-2
n = 100 , left side = 1.39014662943086e-2
        1/n^(7/10) = 3.98107170553497e-2
        difference = 2.59092507610412e-2
n = 200 , left side = 6.63001534179952e-3
        1/n^(7/10) = 2.45063709469745e-2
        difference = 1.78763556051750e-2
n = 500 , left side = 2.57503386325902e-3
        1/n^(7/10) = 1.29039002429643e-2
        difference = 1.03288663797053e-2

```

$$x^3$$

```

n = 10 , left side = 1.69427755592478e-1
        1/n^(7/10) = 1.99526231496888e-1
        difference = 3.00984759044099e-2
n = 20 , left side = 9.31942672923572e-2
        1/n^(7/10) = 1.22822802611579e-1
        difference = 2.96285353192218e-2
n = 50 , left side = 2.69797695441467e-2
        1/n^(7/10) = 6.46727006577358e-2
        difference = 3.76929311135890e-2
n = 100 , left side = 1.14327987447878e-2
        1/n^(7/10) = 3.98107170553497e-2
        difference = 2.83779183105620e-2
n = 200 , left side = 5.21861806171967e-3
        1/n^(7/10) = 2.45063709469745e-2
        difference = 1.92877528852548e-2
n = 500 , left side = 1.97011789902637e-3
        1/n^(7/10) = 1.29039002429643e-2

```

difference = 1.09337823439379e-2

$$x^4$$

n = 10 , left side = 1.73481972152748e-1  
1/n^(7/10) = 1.99526231496888e-1  
difference = 2.60442593441400e-2  
n = 20 , left side = 8.51542996669777e-2  
1/n^(7/10) = 1.22822802611579e-1  
difference = 3.76685029446013e-2  
n = 50 , left side = 2.11276066122370e-2  
1/n^(7/10) = 6.46727006577358e-2  
difference = 4.35450940454988e-2  
n = 100 , left side = 8.32900734622635e-3  
1/n^(7/10) = 3.98107170553497e-2  
difference = 3.14817097091234e-2  
n = 200 , left side = 3.64725636378598e-3  
1/n^(7/10) = 2.45063709469745e-2  
difference = 2.08591145831885e-2  
n = 500 , left side = 1.33955460912746e-3  
1/n^(7/10) = 1.29039002429643e-2  
difference = 1.15643456338369e-2

$$x^{10}$$

n = 10 , left side = 1.10749793713100e-1  
1/n^(7/10) = 1.99526231496888e-1  
difference = 8.87764377837879e-2  
n = 20 , left side = 2.99164984311764e-2  
1/n^(7/10) = 1.22822802611579e-1  
difference = 9.29063041804027e-2  
n = 50 , left side = 2.21641063046967e-3  
1/n^(7/10) = 6.46727006577358e-2  
difference = 6.24562900272661e-2  
n = 100 , left side = 5.38176664980687e-4  
1/n^(7/10) = 3.98107170553497e-2

```

difference = 3.92725403903690e-2
n = 200 , left side = 1.86220228286419e-4
1/n^(7/10) = 2.45063709469745e-2
difference = 2.43201507186881e-2
n = 500 , left side = 5.86797479887602e-5
1/n^(7/10) = 1.29039002429643e-2
difference = 1.28452204949756e-2

```

-----  
A = 3, Power = 7/10, lamda = 1/2, q = 1  
-----

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 6.82869415554089e-2
1/n^(7/10) = 1.99526231496888e-1
difference = 1.31239289941479e-1
n = 20 , left side = 1.33687024165273e-2
1/n^(7/10) = 1.22822802611579e-1
difference = 1.09454100195052e-1
n = 50 , left side = 1.63484873126000e-3
1/n^(7/10) = 6.46727006577358e-2
difference = 6.30378519264757e-2
n = 100 , left side = 3.99163819984172e-4
1/n^(7/10) = 3.98107170553497e-2
difference = 3.94115532353656e-2
n = 200 , left side = 9.92641198009903e-5
1/n^(7/10) = 2.45063709469745e-2
difference = 2.44071068271735e-2
n = 500 , left side = 1.58592157954995e-5
1/n^(7/10) = 1.29039002429643e-2
difference = 1.28880410271688e-2

```

$$x$$

$n = 10$  , left side = 3.69989252549092e-2  
 $1/n^{(7/10)} = 1.99526231496888e-1$   
difference = 1.62527306241979e-1  
 $n = 20$  , left side = 2.00667707762198e-3  
 $1/n^{(7/10)} = 1.22822802611579e-1$   
difference = 1.20816125533957e-1  
 $n = 50$  , left side = 4.68947442600065e-7  
 $1/n^{(7/10)} = 6.46727006577358e-2$   
difference = 6.46722317102932e-2  
 $n = 100$  , left side = 4.87998530473988e-13  
 $1/n^{(7/10)} = 3.98107170553497e-2$   
difference = 3.98107170548617e-2  
 $n = 200$  , left side = 2.77555756156289e-15  
 $1/n^{(7/10)} = 2.45063709469745e-2$   
difference = 2.45063709469717e-2  
 $n = 500$  , left side = 8.32667268468867e-15  
 $1/n^{(7/10)} = 1.29039002429643e-2$   
difference = 1.29039002429560e-2

$$x^2$$

$n = 10$  , left side = 5.10082471986903e-2  
 $1/n^{(7/10)} = 1.99526231496888e-1$   
difference = 1.48517984298198e-1  
 $n = 20$  , left side = 2.49080317693943e-2  
 $1/n^{(7/10)} = 1.22822802611579e-1$   
difference = 9.79147708421848e-2  
 $n = 50$  , left side = 4.49384626232519e-3  
 $1/n^{(7/10)} = 6.46727006577358e-2$   
difference = 6.01788543954106e-2  
 $n = 100$  , left side = 1.12364228202105e-3  
 $1/n^{(7/10)} = 3.98107170553497e-2$   
difference = 3.86870747733287e-2  
 $n = 200$  , left side = 2.80910570690518e-4  
 $1/n^{(7/10)} = 2.45063709469745e-2$   
difference = 2.42254603762840e-2

n = 500 , left side = 4.49456913103607e-5  
 1/n^(7/10) = 1.29039002429643e-2  
 difference = 1.28589545516540e-2

$$x^3$$

n = 10 , left side = 8.05630984900003e-2  
 1/n^(7/10) = 1.99526231496888e-1  
 difference = 1.18963133006888e-1  
 n = 20 , left side = 3.80461039225837e-2  
 1/n^(7/10) = 1.22822802611579e-1  
 difference = 8.47766986889953e-2  
 n = 50 , left side = 6.74097872481336e-3  
 1/n^(7/10) = 6.46727006577358e-2  
 difference = 5.79317219329224e-2  
 n = 100 , left side = 1.68546342326287e-3  
 1/n^(7/10) = 3.98107170553497e-2  
 difference = 3.81252536320869e-2  
 n = 200 , left side = 4.21365856036027e-4  
 1/n^(7/10) = 2.45063709469745e-2  
 difference = 2.40850050909385e-2  
 n = 500 , left side = 6.74185369657354e-5  
 1/n^(7/10) = 1.29039002429643e-2  
 difference = 1.28364817059986e-2

$$x^4$$

n = 10 , left side = 9.56553116582347e-2  
 1/n^(7/10) = 1.99526231496888e-1  
 difference = 1.03870919838653e-1  
 n = 20 , left side = 4.04460065482376e-2  
 1/n^(7/10) = 1.22822802611579e-1  
 difference = 8.23767960633414e-2  
 n = 50 , left side = 6.82428115714757e-3  
 1/n^(7/10) = 6.46727006577358e-2  
 difference = 5.78484195005882e-2

```

n = 100 , left side = 1.69067633411174e-3
          1/n^(7/10) = 3.98107170553497e-2
          difference = 3.81200407212380e-2
n = 200 , left side = 4.21691662969348e-4
          1/n^(7/10) = 2.45063709469745e-2
          difference = 2.40846792840052e-2
n = 500 , left side = 6.74268776228587e-5
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.28364733653415e-2

```

$$x^{10}$$

```

n = 10 , left side = 6.41007338310152e-2
          1/n^(7/10) = 1.99526231496888e-1
          difference = 1.35425497665873e-1
n = 20 , left side = 1.60696284616728e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 1.06753174149906e-1
n = 50 , left side = 1.11077199106476e-3
          1/n^(7/10) = 6.46727006577358e-2
          difference = 6.35619286666710e-2
n = 100 , left side = 2.15342826708947e-4
          1/n^(7/10) = 3.98107170553497e-2
          difference = 3.95953742286408e-2
n = 200 , left side = 5.04590230707082e-5
          1/n^(7/10) = 2.45063709469745e-2
          difference = 2.44559119239038e-2
n = 500 , left side = 7.92802313141143e-6
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.28959722198329e-2

```

---

A = 3, Power = 7/10, lamda = 1, q = 1/4

---

$$x^{\frac{1}{3}}$$

```

n = 10 , left side = 5.07301387715013e-2
          1/n^(7/10) = 1.99526231496888e-1
          difference = 1.48796092725387e-1
n = 20 , left side = 2.97571823804906e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 9.30656202310884e-2
n = 50 , left side = 1.27350011672377e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = 5.19376994904981e-2
n = 100 , left side = 6.51783250464703e-3
          1/n^(7/10) = 3.98107170553497e-2
          difference = 3.32928845507027e-2
n = 200 , left side = 3.29808623350129e-3
          1/n^(7/10) = 2.45063709469745e-2
          difference = 2.12082847134732e-2
n = 500 , left side = 1.32886374798369e-3
          1/n^(7/10) = 1.29039002429643e-2
          difference = 1.15750364949806e-2

```

$$x$$

```

n = 10 , left side = 1.20447685814792e-1
          1/n^(7/10) = 1.99526231496888e-1
          difference = 7.90785456820962e-2
n = 20 , left side = 6.30698667036227e-2
          1/n^(7/10) = 1.22822802611579e-1
          difference = 5.97529359079563e-2
n = 50 , left side = 2.52371937308606e-2
          1/n^(7/10) = 6.46727006577358e-2
          difference = 3.94355069268752e-2
n = 100 , left side = 1.26185968662246e-2
          1/n^(7/10) = 3.98107170553497e-2
          difference = 2.71921201891251e-2
n = 200 , left side = 6.30929843311230e-3

```



```

1/n^(7/10) = 2.45063709469745e-2
difference = 1.81970725138622e-2
n = 500 , left side = 2.52371937324492e-3
1/n^(7/10) = 1.29039002429643e-2
difference = 1.03801808697194e-2

```

$$x^2$$

```

n = 10 , left side = 1.62756694980023e-1
1/n^(7/10) = 1.99526231496888e-1
difference = 3.67695365168652e-2
n = 20 , left side = 7.46838649241749e-2
1/n^(7/10) = 1.22822802611579e-1
difference = 4.81389376874042e-2
n = 50 , left side = 2.70977519295812e-2
1/n^(7/10) = 6.46727006577358e-2
difference = 3.75749487281546e-2
n = 100 , left side = 1.30837364161245e-2
1/n^(7/10) = 3.98107170553497e-2
difference = 2.67269806392252e-2
n = 200 , left side = 6.42558332058729e-3
1/n^(7/10) = 2.45063709469745e-2
difference = 1.80807876263872e-2
n = 500 , left side = 2.54232495524092e-3
1/n^(7/10) = 1.29039002429643e-2
difference = 1.03615752877234e-2

```

$$x^3$$

```

n = 10 , left side = 1.64347075123365e-1
1/n^(7/10) = 1.99526231496888e-1
difference = 3.51791563735233e-2
n = 20 , left side = 6.64134500436401e-2
1/n^(7/10) = 1.22822802611579e-1
difference = 5.64093525679389e-2
n = 50 , left side = 2.18274504096767e-2

```

```

1/n^(7/10) = 6.46727006577358e-2
difference = 4.28452502480591e-2
n = 100 , left side = 1.01752467012584e-2
1/n^(7/10) = 3.98107170553497e-2
difference = 2.96354703540914e-2
n = 200 , left side = 4.90809987188921e-3
1/n^(7/10) = 2.45063709469745e-2
difference = 1.95982710750853e-2
n = 500 , left side = 1.92080662074161e-3
1/n^(7/10) = 1.29039002429643e-2
difference = 1.09830936222227e-2

```

$$x^4$$

```

n = 10 , left side = 1.49500436265984e-1
1/n^(7/10) = 1.99526231496888e-1
difference = 5.00257952309041e-2
n = 20 , left side = 5.27597929216736e-2
1/n^(7/10) = 1.22822802611579e-1
difference = 7.00630096899054e-2
n = 50 , left side = 1.56378486874087e-2
1/n^(7/10) = 6.46727006577358e-2
difference = 4.90348519703270e-2
n = 100 , left side = 7.03487339252017e-3
1/n^(7/10) = 3.98107170553497e-2
difference = 3.27758436628296e-2
n = 200 , left side = 3.33251686577100e-3
1/n^(7/10) = 2.45063709469745e-2
difference = 2.11738540812035e-2
n = 500 , left side = 1.28998659313402e-3
1/n^(7/10) = 1.29039002429643e-2
difference = 1.16139136498303e-2

```

$$x^{10}$$

```

n = 10 , left side = 6.20895791074231e-2

```

```

          1/n^(7/10) = 1.99526231496888e-1
          difference = 1.37436652389465e-1
n = 20 , left side = 7.49326050835418e-3
          1/n^(7/10) = 1.22822802611579e-1
          difference = 1.15329542103225e-1
n = 50 , left side = 9.67306970003267e-4
          1/n^(7/10) = 6.46727006577358e-2
          difference = 6.37053936877325e-2

```

## References

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